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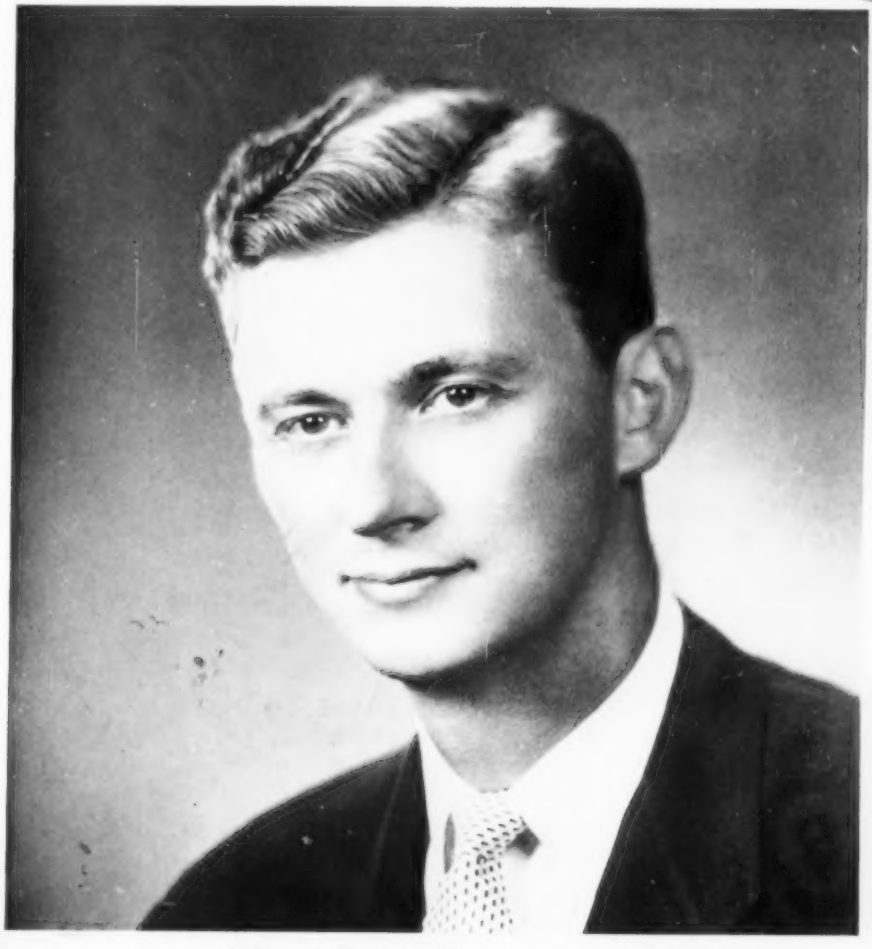
# JOURNAL

VOLUME 9 NUMBER 7 • SEPTEMBER, 1953



SPE's new Executive-Secretary James Underwood.
(See story on page 5)

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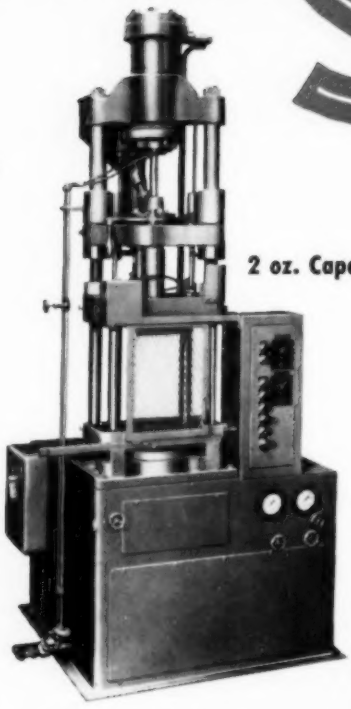

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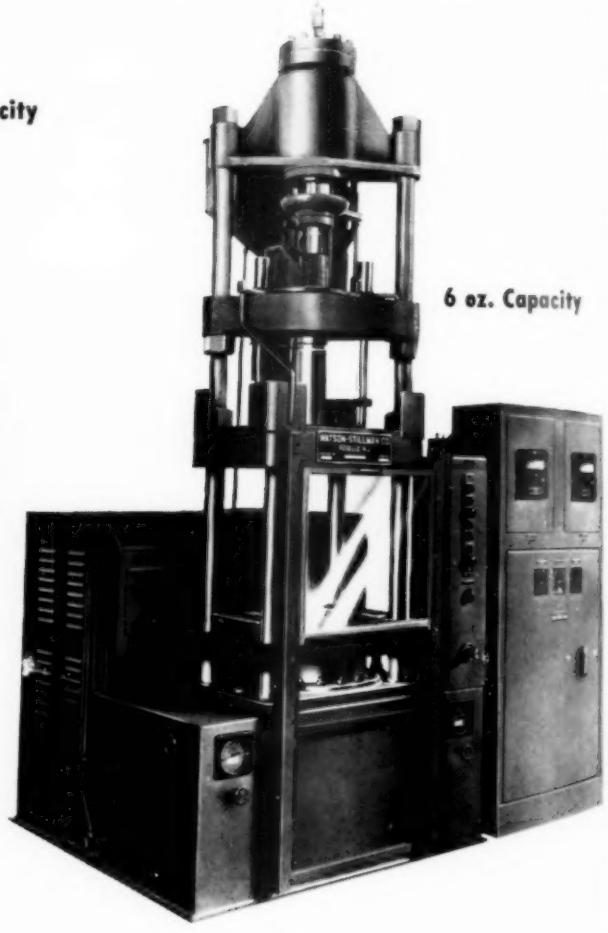

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# JOURNAL

Vol. 9 September 1953 No. 7

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## INDEX


JAMES UNDERWOOD, SPE's Executive Secretary ..... 5
Toronto is Host to SPE's 10th Conference ..... 7

### ARTICLES

Printed Circuits—Norman Skow ..... 9
Unplasticized PVC—George S. Laaff ..... 14
Changes in Cross-Section on Extrusion—Zvi Rigbi ..... 22
Successful Designing for Plastics Molding—W. M. Halliday ..... 24

### FEATURES

The Injection Molderscope ..... 26
Plastics Around the World ..... 27
News of the Sections ..... 30

### ADVERTISERS

Bakelite Co., Div. of Union Carbide and Carbon Corp. ... 4
A. Bamberger Corp. ..... 40
Barrier-Pribble and Co., Inc. ..... 40
Frank W. Egan and Co. ..... 35
Glengarry Equipment Corp. ..... 23
Industrial Manufacturing Corp. ..... 40
Injection Molders Supply Co. ..... 7, 33
Koppers Co., Inc. ..... 6
Manco Products ..... 30
Metasap Chemical Co. ..... 8
Monsanto Chemical Co. ..... 13
Newark Die Co. ..... 21
Shell Chemical Corp. ..... 39
Thoreson-McCosh, Inc. ..... 37
The Watson-Stillman Co. ..... 2

CLASSIFIED ADS ..... 38



*The Society of Plastics Engineers Journal is not responsible for the views expressed by individual contributors. Copy for each issue should be received at The Security Bank Bldg., Athens, Ohio before the first of the preceding month.*


## *Across the Editor's Desk*

The May issue of the Journal carried an unusually interesting cover picture, showing a transparent Plexiglas stamp being used to ink an electrical circuit symbol into a drawing. The manufacturers of this time-saver put out a wonderful variety of such stamps, each a part of an electrical circuit, so that complex drawings can be made using these stamps to produce a professional job with a great saving of time. Manufacturer is John Griffin Co., 2157 James Ave., St. Paul 5, Minn., and we hereby make belated acknowledgement of their courtesy in providing the photo.

## *Book Review*

### ASTM STANDARDS ON PLASTICS

This 705-page book gives a large number of standards, including specifications, definitions and tests for a wide range of plastics. Most of the 135 standards which are included have been developed through the work of ASTM Committee D-20 on Plastics. The Committee for many years has been perfecting methods of testing, and those included are considered to be the best available at this time. In addition to the standards covered by Committee D-20, there are a number that are pertinent from other fields, including electrical insulation.

The 27 specifications cover quite a wide range of molding compounds such as phenolic, polystyrene, melamines, ureas, cellulose, acetates, vinyl chloride, methacrylate, and materials made from these compounds in the form of sheets, rods, tubes and shapes.

Copies of this 705-page publication can be obtained from Headquarters of the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. at $5.25 each, in heavy paper cover. Because of the widespread use of this publication, reduced prices are in effect on orders in quantity.

### SPE PRIZE PAPER CONTEST

**$200 $100 $50**

*Who may enter?* Everyone.

*What may be the subject matter?* Any phase of the plastics industry; material, machinery, processes, etc.

*What length should the paper be?* Long enough to tell the story. There are no restrictions on length.

*When must it be submitted?* As soon as possible; not later than the first of November.

*Where should it be submitted?* To your local section, or for non-members, to the nearest local section or national office.

*Why should I write a paper?* To let the men in the plastics industry know that **you** have something on the ball, that **you** can work out new ideas. To help others in your industry. Perhaps to make a little spending money.

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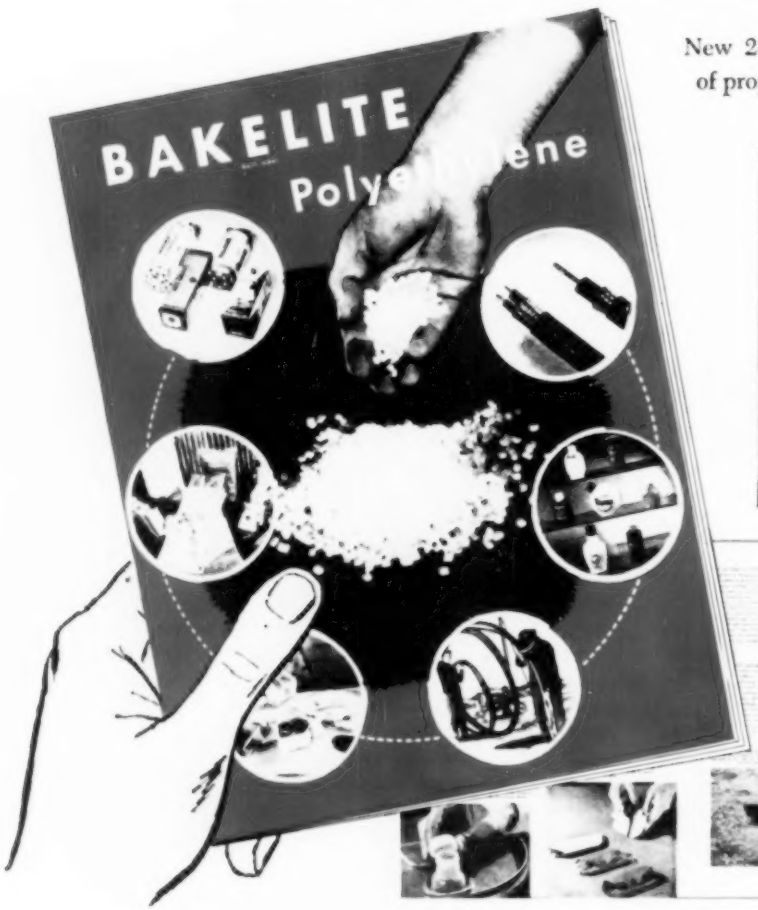


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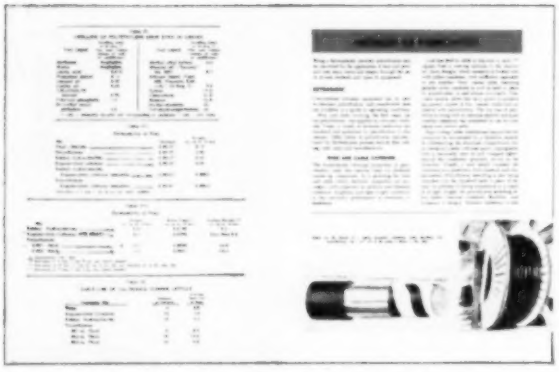

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# James Underwood– SPE's National Executive-Secretary

One of the major problems confronting your National Council this year was the selection of an Executive Secretary to take Mrs. Bess Day's place. Mrs. Day's resignation was regretfully accepted in January at her insistence.

The Council at that time authorized the Executive Committee to select a successor. Over one hundred and fifty applications were screened and your executive committee interviewed about 20 applicants. At the June council meeting two of these applicants were interviewed and Mr. P. J. Underwood was selected. Mr. Underwood has been at the National Office since July 20 and is working with Mrs. Day learning the routine and functions of the office. Mrs. Day has kindly consented to work with Mr. Underwood until September 1st, 1953.

Mr. Underwood is 27 years old, was born in and is a native of New Jersey.

After being educated in the public schools of Montclair, New Jersey, he entered the Navy in 1944 and was selected for Officers Training at Vanderbilt University, Nashville, Tennessee. Honorably discharged after two years of service, he completed the requirements for his degree at Hamilton College, Clinton, New York. He received his Bachelor of Arts in Economics and Political Science with honors in June 1949. He attended Georgetown Law School and is a member of the Delta Theta Phi Law Fraternity.

Early in his career, Mr. Underwood did analytical work in the Credit Department of the Irving Trust Company, Wall Street, New York. In 1951, he accepted a position with the Department of Commerce and went to Washington, D. C. He became a Commodity-Industry Analyst in the Miscellaneous Metals and Minerals Division of the National Production Authority.

More recently, Mr. Underwood has been engaged in organizational and public relations work in trade associations in Washington. He was Field Representative promoting association memberships, and as a member of the firm of Robert Martin Associates served as Executive Assistant to the Vitrified China Association.

Mr. Underwood is unmarried but far from a confirmed bachelor.

Your Executive Committee and Council are sure Mr. Underwood will be a very fine executive secretary. He has many problems to solve in order to implement the policies laid down by your National Council and he will need the cooperation of each section and all the members, which I am sure he will receive.

Mr. Ed Childs, president of the Western New England section suggested to me that the best way to stimulate the growth of the Society and interest of the local sections was to have Mr. Underwood visit the local sections. Unfortunately the National budget will not at present stand such traveling costs. However, there undoubtedly are many local sections who can afford to pay Mr. Underwood's traveling expenses. Western New England has already invited Mr. Underwood to visit them and I'm sure there are many other sections who would like to do the same.

Lets all give Mr. Underwood our full cooperation and support.

Walter Oelman
*National President, SPE*

# Your National Office

It is a very great honor to accept the appointment as the Executive Secretary of your Society. The Society of Plastics Engineers has become one of the important professional associations in the United States and Canada. In ten years it has grown to a membership of more than 2500 individuals with 27 active local sections representing the Society and fulfilling its purposes in all parts of this country and Canada. It is indeed an honor for me to be associated with an organization of such stature as membership in it is a distinction for each of you.

My earnest desire is to meet as many members as possible, as soon as possible, for I believe the closer the tie between the members, the local sections, and the National Office, the stronger will be our organization. Through this strength we will continue to grow and achieve with greater success than ever the aim of this Society "to promote in all lawful ways the arts, sciences, standards and engineering practices connected with the use of plastics".

Ed Childs, on behalf of the Western New England Section, has already extended a generous invitation for me to attend the Section's opening meeting of this fiscal year on September 9. As your National Office representative, I am looking forward very much to meeting with the members of this important section and with all of you during the coming year.

The National Office exists to serve each individual member of the Society and to coordinate the activities of the local sections. The staff and I will devote ourselves to these activities for the continued growth and success of the Society.

P. J. Underwood
*Executive-Secretary*

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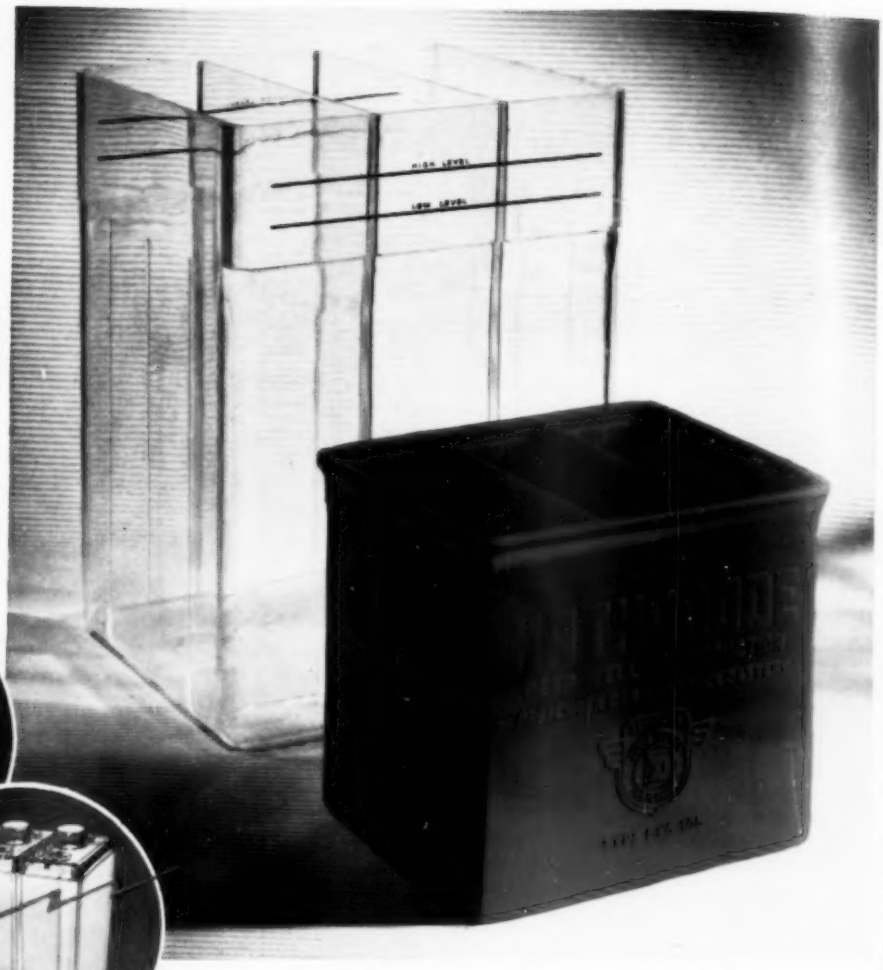

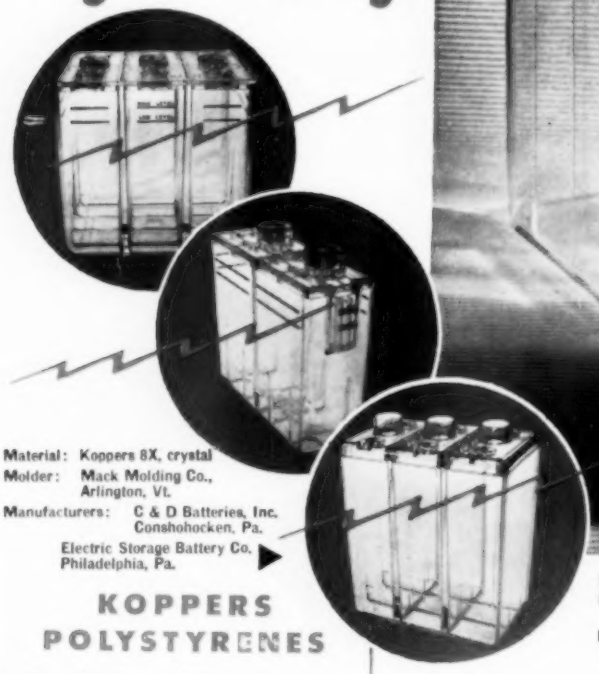

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| MC-309 | High Impact, Highest Heat Distortion Temperature |
| MC-401 | Medium Impact, Improved Heat Distortion Temperature |
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# Toronto, Superlative City, Host to Tenth SPE Conference

Toronto, Queen City of the great Canadian Province of Ontario, is the 1954 Convention City for the 10th Annual National Technical Conference of the Society of Plastics Engineers, Inc. Toronto is known by its envious rivals as "Hog Town," because it manages to take for itself an out-size share of all that is good in Canada; and "Toronto the Good," because, like Boston and Philadelphia, its people have always tried to put their more moral foot forward, while tapping a somewhat wordly "off beat" with the other.

Greater Toronto claims about 1,500,000 population, and is rated one of the fastest growing cities in North America. Too big to be called a "boom town," it is the New World city international industrialists are betting will become one of the three great metropoli of the western hemisphere. The victim of a comparatively late start, industrially speaking, Toronto today is as new and stimulating as the plastics industry, as basic in its forward drive as the vast mineral development now pacing all Canada towards full industrial maturity. Toronto is rather more proud of owning the biggest "Folly" in North America. This is Casa Loma, a vast castle built by a temporarily prosperous Canadian knight, who spent $3,000,000 "real" dollars on it before he ran out of money to buy more of its 14-karat gold bath taps and fittings. The castle can be visited.

Historically, Toronto is interesting because, during the War of 1812, U. S. forces burnt the province's parliament buildings. Canadian forces retaliated by burning the residence of the U. S. president in Washington. During restoration white paint was used to hide the fire scars. Hence, the White House. Today, Toronto has a large and efficient fire department.

Toronto is the cultural centre of English-speaking Canada. The city has a Symphony orchestra, is an occasional "try-out" city for Broadway plays, and has the usual assortment of museums, universities, churches and cathedrals one might expect of a large North American city.

Toronto is the "hot music" capital of Canada and is a port of call for all the great American and European entertainers of our time. Night clubs and other places of entertainment are numerous and extremely varied in style and appeal.

Ontario, of which, Toronto is the capital, is as large as Texas, New Mexico and a third of Arizona combined. Its southern tip extends deep into the United States to a degree of latitude south of the northern borders of California. Toronto is a "top coat" city in the Winter, though milder in climate than New York or Chicago; a tropical suit town in the Summer, when the weather is generally more humid than hot. Warmest mid-Winter day in '52 was 60 degrees, and the thermometer never dropped below zero.

Toronto is a great businessman's town. Home of the International Trade Fair—largest merchandising mart of its kind in the world; the Canadian National Exhibition—world's largest annual fair, it is a combination of world trading post, industrial cross-roads, and Mecca for new investment capital without parallel in the western hemisphere. In volume of trading the Toronto Stock Exchange is the second largest in the world.

Toronto is a typically North American city in its enthusiasm for superlatives. However, Torontonians take for granted their city has the tallest building—and the largest hotel—The Royal York, convention headquarters—in the British Empire. Restaurants range from the routine to the very fine; one in particular is called "one of North America's 10 best."

The city was settled largely by Scots, Irish and English, but is today as cheerfully polygot as any on the Continent.

To delegates anxious to combine a typical Winter holiday with their convention visit, they will find almost any part of the surrounding countryside suitable for this purpose. However, as snow conditions are no more certain in Southern Ontario

(Please turn to page 34)

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# Stearates

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Dr. Norman Skow

# Printed Circuits

Norman Skow

*Director of Research*
*Synthane Corporation*

*Presented at the Spring Meeting of the American Society of Mechanical Engineers Columbus, Ohio, April 28, 1953*

**A printed circuit is a metal reproduction of a conductor pattern which has been bonded to an insulating material. Serving as a conducting medium in electronic assemblies, such circuits replace to a large extent the internal maze of wires normally found in conventionally assembled equipment.**

**Printed circuits have been achieved by plating metal patterns on plastic boards, by spraying metal into depressions in a plastic plate, by bonding rigid wiring harness to a plastic base, by fusing silver ink patterns on ceramics, or by etching of metal-clad plastics. The latter method is currently gaining in popularity and seems to be admirably suited to mass production assembly procedures required in the highly competitive electronics industry.**

**The simplicity and uniformity of printed circuitry offer tremendous economic advantages in the production of all types of electronic equipment. Elimination of manual wiring speeds assembly and, because mechanical reproduction reduces the probability of error, inspection time is automatically shortened while assemblies become more uniform and reliable.**

THE ELECTRICAL PROPERTIES of printed circuits are largely determined by the base laminate, the metal foil and the adhesive used to bond the two. For most printed circuit applications, copper foil in a variety of thicknesses is bonded under heat and pressure to one or both sides of thermosetting laminated sheet stock of the desired grade and thickness.

Numerous experiments have been made to determine the suitability of copper, aluminum, brass and silver foils. Of these, copper has been the most widely used; however, other metals are rapidly gaining in popularity. Silver and brass possess excellent current-carrying characteristics but suitable adhesives have not been developed which can produce a bond sufficiently strong for most service conditions. On the other hand, aluminum bonds well but poses a number of problems in soldering techniques. A partial solution to the soldering difficulty has been accomplished by using a thin layer of copper or tin alloy on one surface of the aluminum foil.

For printed circuit applications, electrolytically deposited copper foil is preferred over that produced by the time-honored rolling method. Rolled copper is undesirable for the following reasons:

1. Insufficient width. Rolled foil is too narrow (6-to 12-inches depending upon thickness) for efficient and economical bonding practices.
2. Rolling operations generate considerable heat which sometimes produce burned spots in the foil.
3. Rolled copper is likely to contain or pick up traces of other metals which might influence the accuracy of etching. Such a condition could also interfere with the production of the extremely fine lines required for certain circuits.
4. Lubrication applied during rolling operations tends to reduce bonding properties of the adhesives. The result is a non-uniform bond of foil to the sheet of dielectric.

None of the above mentioned drawbacks applies to electrolytically produced copper foil which is practically pure and is available in various thicknesses and widths up to sixty-four inches. Although this process was developed long before the advent of etched circuits, full advantage is taken of the fact that foil thus produced is admirably suited for this purpose. Electrolytically deposited as a thin layer on a smooth, revolving lead drum, a foil is stripped off which has one extremely smooth side while the other side is relatively rough. This smooth side permits uniformity of etching while the rough side becomes an ideal surface for bonding.

Thin copper sheets used in the building trades are also produced by the electrolytic process but quality control is much more rigid for grades which will ultimately be used in printed circuits. Each roll is inspected for the pits, scratches, wrinkles, nodules or pin holes which will render it unsuitable for electronic use. Extreme care during handling must also be observed because oxidation resulting from fingerprints allows these areas to etch at a different rate of speed than unoxidized areas. For printed circuits foil thicknesses of 0.00135 inch and 0.0027 inch are most commonly used.

The most satisfactory printed circuit dielectric or insulating material developed thus far is the thermosetting laminated plastics. Any of the twenty-odd standard grades of thermosetting laminated products described in NEMA* STANDARDS FOR LAMINATED THERMOSETTING PRODUCTS (Pub. No. LP1 - 1951) will produce a satisfactory bond with copper. The most generally satisfactory insulating or dielectric material in use today is NEMA Grade XXXP. This thermosetting laminate utilizes a paper filler and is produced, as are all laminates, by impregnating or coating the filler material with a thermosetting resin and consolidating a predetermined number of layers under temperature and high pressure. The ensuing chemical reaction transforms the layers into a hard, dense solid which will not delaminate and cannot be resoftened by the application of heat. Even in thin sheets, XXXP grade combines excellent electrical properties with the good machinability so necessary for punching operations. In addition, this laminate is sufficiently hard to maintain a smooth surface after the metal foil has been bonded.

Laminates other than phenolics, such as melamine and silicone may also be used. Melamine resins are used where arc resistance is an important factor, and silicone resins are used when heat resistance is required. Flame-retardant additives may be incorporated into most of the thermosetting resins and these tend to increase the resistance of the laminate to flame. It is important to select additives which do not detract from the electrical and mechanical properties of the laminate. No standards have as yet been established for flame-resistance tests.

* *National Electrical Manufacturer's Association, a non-profit trade association of manufacturers of electrical apparatus and supplies. The STANDARDS publication is largely the result of cooperative work with the military services, particularly the Bureau of Ships of the Navy Department. It presents a simplification of test procedures and standards and emphasizes the properties vital to each grade.*

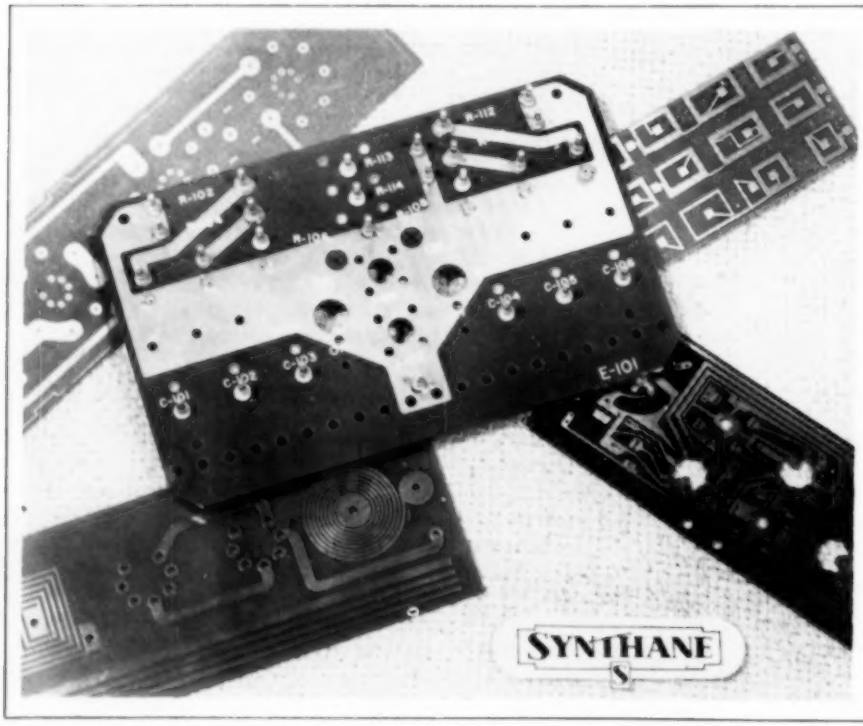
**Bonding**

A great number of proprietory compounds are available for bonding metal foils to base laminates. These compounds include phenolic, melamine, urea, and vinyl resins. Adequate bonding, however, is a formidable problem. The proper adhesive must be sufficiently strong, must possess good heat resistance to permit soldering without blistering, be resistant to shock and moisture, and must at least match the laminate in electrical properties. Thermoplastic adhesives are characterized by their susceptibility to blistering during soldering operations and also have too much cold flow under normal operating conditions. On the other hand, common thermosetting adhesives do not possess the required shock resistance and do not bond the copper foil as well as desired. This problem has been solved by developing specially formulated mixtures of both thermosetting and thermoplastic resins. A typical example of such a formula is No. 21013, made by the Armstrong Cork Company from a mixture of phenolic and vinyl resins.

The actual mechanics of bonding foil to a laminate may be accomplished by one of two methods. Class 1 copper-clad laminate is produced from a predetermined number of resin-impregnated sheets to which is added a thin, dry sheet of adhesive film followed by a sheet of copper foil. The entire build-up is then subjected to heat (approximately 320°F) and high pressure (approximately 1000 lbs. per sq. inch) for about one hour. If desired, the adhesive film and foil may be added to both sides of the build-up.

Class 2 copper-clad laminate is designed to meet closer thickness tolerances than Class 1 material. It is produced by sanding a finished, cured sheet of laminate to the desired thickness, after which the adhesive and copper foil are added. It is then returned to the press for a second application of heat and pressure. Because of the additional work involved, Class 2 material is more expensive than Class 1.

After bonding, copper-clad sheets are usually sprayed with a strippable plastic film for protection against




PRINTED CIRCUITS — Etched patterns are extremely accurate reproductions of the original design. Fine lines or complex shapes can be reproduced indefinitely without variation or loss of detail.

1. MAKING UP FOIL-CLAD LAMINATES—Make-up for each sheet of foil-clad material consists of arranging laminate, adhesive (dry film in this instance), and copper foil in proper sequence. Adhesive must contact rough side of both laminate and foil for best possible bond.

2. STACKING MAKE-UP FOR BONDING—Make-up for each sheet of foil-clad is sandwiched between clean, smooth steel press plates. These assemblies are then stacked five high (called a pack) for insertion in hydraulic presses where bonding takes place under heat and pressure.

scratching, oxidation and scarring during subsequent trimming, packing and shipping operations.

### Properties of Copper-Clad Sheets

The principal requirements for finished sheets of foil-clad laminated materials are their ability to resist peeling, and resistance to heat and moisture. Other important considerations are that the copper surface be substantially free of wrinkles, pits, nodules, scratches, pin holes and oxidized areas. It must be uniformly thick otherwise it would be impossible to etch to fine lines. The copper must also be relatively soft in order to retain proper punching characteristics.

The adhesive layer must possess good electrical properties and be resistant to moisture. When bonded, it becomes an integral part of the sheet of dielectric and must match the selected grade of laminate in NEMA characteristics.

A quality control check on the laminate is made to determine the water resistance and dissipation factor at one megacycle after immersion in water for 24 hours at room temperature. These tests are made according to procedures designated by ASTM*.

Bond strength varies with the thickness of the copper. For copper 0.00135 inch in thickness the bond varies from 3 to 5 pounds. For copper 0.0027 inch in thickness the bond varies from 4 to 6 pounds. The bond strength test is made as follows: Four specimens, two in the lengthwise direction and two in the crosswise direction, each 1"x4"x thickness, are cut from a sheet. The copper foil is peeled back from one end of the specimen approximately one inch so that the line of peel is perpendicular to the edge of the specimen. The specimen is then supported in a horizontal plane with the peeled copper strip down between two solid supports adjusted to provide a 3/4 inch span. The end of the peeled strip is clamped between two knurled jaws to which is attached a light container. The jaws must cover the full width of the strip and are clamped parallel to the line of peel. Sand or lead shot is poured at approximately

* *American Society for Testing Materials*
*Water Absorption test* — *ASTM — D — 229*
*Dissipation Factor test* — *ASTM — D — 150*

3. ALIGNING PACKS IN PRESS—Operator loads packs in 10 opening press. Ends must be carefully aligned before pressure is applied. After one hour at 350° and 1000 lbs. per sq. in. pressure, adhesive material has polymerized to form a strong bond between the foil and laminate.

4. FINISHED SHEETS—After being removed from the laminating presses, each foil-clad sheet is carefully inspected for faults, principally blistering, cracks, or improper bonding.

two pounds per minute into the container until the strip begins to peel and at that point the weight of the total load is noted. Average value for the four specimens is the bond strength of the composite sheet of surface tested.

The heat resistance of the copper-clad laminate is determined by two tests: the oven test and the hot solder test. When the material is subjected to an oven temperature of 250°F for thirty minutes no blistering should occur. This test is conducted by supporting an unconditioned specimen 6"x6" in a non-metallic rack in a horizontal-flow air-circulating-oven maintained at 250°F. plus or minus 4°F. Examination of the specimen after 30 minutes should reveal no blisters.

The hot solder test is accomplished by floating a 1"x1" unconditioned specimen (copper-side-to-be-tested down) in clean molten solder at a temperature of 450°F. When the material is subjected to the hot solder for ten seconds no blistering should be evident.

Foil-clad laminates meeting the above specifications have proved to be eminently successful for practically all type of printed circuit applications.

### Etching

Etching chemicals vary with the foil. For copper and brass, 38 to 40° Baume' ferric chloride solution is used; for aluminum, hydrochloric acid; for silver, 30% nitric acid. These solutions are normally used at 85 to 95°F.

Etching time varies with the equipment used. In paddle-type etchers, cup-shaped paddles on a rotating shaft pick up the etching solution and coat the surface to be etched with a fine spray. Using this method, copper foil 0.00135-in. thick will be etched through in about 2 minutes. The number of plates which can be etched at one time in a paddle-type etcher is limited.

Tanks are more practical for mass production. The etching solution is placed in a suitable tank and agitation is provided, usually by compressed air jets. The sheets to be etched are either racked or hung in the tank or carried through the tank by a conveyor. Etching time for copper foil in this sort of equipment will vary from 10 to 20 minutes.

In any type of printed circuit etching where quality and consistency are important, a careful control over solution concentration, temperature and degree of exhaustion must be maintained. Timing is important to prevent over-etching and excessive undercutting of the resist.

### Fabrication

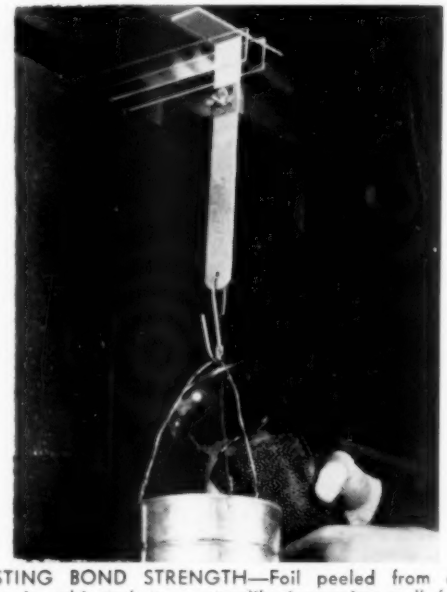
In general, foil-clad laminates may be fabricated with the same machinery and methods used for sheets without the foil. Shearing and sawing offer no additional complications. Special care must be taken in the design of progressive piercing and blanking dies so that the stripper plate will prevent any lifting of the foil as punches are withdrawn. Drills should be sharpened with a negative rake similar to that used when drilling aluminum. When so ground, they will not catch the foil and lift it away from the laminate when holes are drilled through a narrow line of metal or at the termination of a line.

Rapid punching in exact register with the etched pattern is really the only difficult fabrication problem to be met. No general solution exists, however, since each printed circuit is of a different size and shape and the method of handling will depend on the type of tools required, the length of the strips, and a number of other factors.

### Assembly

Methods of assembly of printed circuits into finished electronic or electrical devices are as varied as the applications. The most obvious method is to simply punch or

5. PROTECTIVE COATING—As protection against scratching and oxidation during shipment or subsequent handling, foil-clad sheets may be sprayed with a protective coating, usually a vinyl resin.



6. TESTING BOND STRENGTH—Foil peeled from a test strip is subjected to a steadily increasing pull from a suspended load. Bond strength is computed from weight of load required to cause further separation of foil from laminate.

drill holes through the conductor and the laminate, insert leads of standard components into the holes, and solder the leads to the conductors. Complicated circuitry is normally laid out on both sides of the piece to provide for crossovers. Connections between conductors on opposite sides may be made by component leads, tinned eyelets, rivets, pins, or simply short lengths of wire. Using the proper laminate, components can be unsoldered and resoldered several times before foil shows a tendency to lift from the base.

Dip soldering has been proven quite practical as an assembly technique for smaller units. With all of the circuitry placed on one side of the dielectric, holes about 0.040 to 0.045 in. in diameter are punched or drilled to take the leads of resistors, capacitors, subminiature tubes, etc. All of the components are placed in position on the

(Please turn to page 38)

# Now you can injection-mold vinyl chloride products

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# *Unplasticized* PVC

George S. Laaff

*Director of Research and Development*
*The Bolta Co.*

*Presented at the Spring Meeting of the American Society of Mechanical Engineers*

**Corrosion has always been a problem wherever structural materials were used. The metals generally are good. They have strength and hardness but they conduct electricity, oxidize and are reactive chemically with many materials.**

**Wood is a fine structural material. It has strength, lightness, is cheap and available, but it burns and rots. It is attacked by termites, absorbs moisture and has no great chemical resistance.**

**Ceramics and glass have merit. They have strength, clarity, chemical resistance and heat stability. They are non-conductors, but both are brittle and present difficulties in fabrication.**

**Plastics have excellent chemical resistance and are non-conductors. Generally, their low heat resistance leaves something to be desired. In a multiplicity of processes, however, aqueous solutions at temperatures of from 40-150°F are encountered. Unplasticized PVC is outstanding among the plastics at these temperatures for general chemical resistance, tensile strength, impact strength and dimensional stability.**

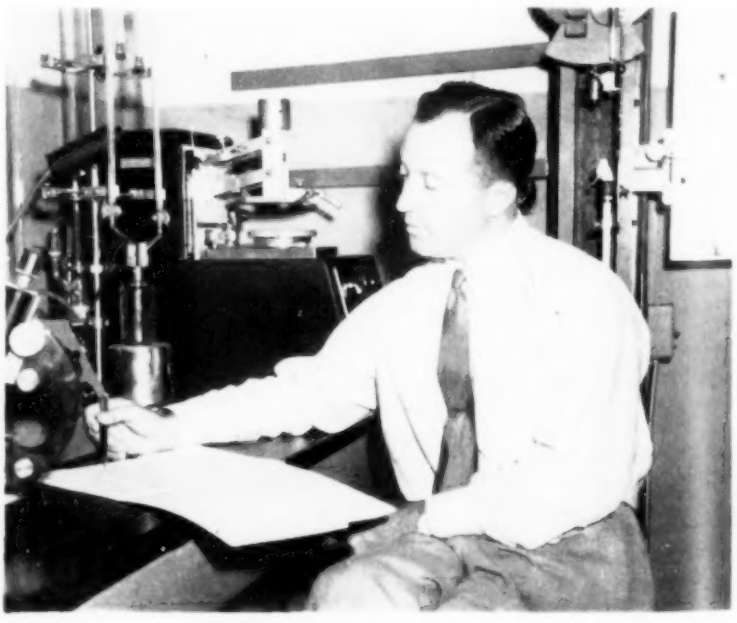
THE PRESENT BASIC ability to produce unplasticized PVC cannot directly be attributed to a particular effort toward taking an early vinyl resin and then developing equipment and technique to process it into a structural material with high chemical resistance. The discovery that a vinyl chloride resin could be plasticized with tricresecyl phosphate to produce a dry, flexible material opened a wide field for possible applications. This plasticized vinyl was processed into sheets and films for upholstery, drapes, tarpaulins, flooring, wall covering, liners for irrigation ditches, sunshades for tobacco fields, packaging and inflatable toys, etc. Plasticized vinyl was also extruded as wire coverings, garden hose, shoe welting, clothes lines, etc. With this market and all its economic attraction, the production of vinyl chloride resins went from 1 million lbs. in 1940 to 350 million lbs. in 1952.

The impetus of this market was great, and development was rapid. Resins, plasticizers, stabilizers, colorants, equipment, and techniques grew apace. The quality of the resins was improved through a greater knowledge of the polymerization reaction and a better understanding of the processors' requirements. To process the material more accurately and economically, Banbury mixers, mills, calenders, and extruders were improved and refined. Perhaps the greatest improvements were along the line of instrumentation and equipment control, where the latest developments were fully utilized. Other techniques were brought about through the rapid growth of plastics companies. Engineers moved in from the paper, textile, and metal fields with excellent suggestions on processing and techniques. The general fund of information has grown rapidly.

All of these developments were at hand when the knowledge of the German achievements with unplasticized PVC became generally known. In spite of the already over-taxed capacities of many of our plants, the development of satisfactory unplasticized PVC in the U. S. proceeded rapidly.

The Germans have proved the basic concept that polyvinyl chloride when used as a corrosion resistant material, must be as unadulterated as possible. Domestic PVC producers quickly realized the problem of making resins that could be processed without adulteration in the equipment at hand. Processors, who had long used plasticizers and practically anything else that would help processing, were tempted to modify their formulations to some extent. These little sins are immediately apparent in subsequent physical and chemical tests. An unplasticized vinyl compound must be as nearly 100% resin as possible. This holds true for all materials whether converted by extrusion, by calendering, by laminating or by molding.

Only through the use of unadulterated materials, can the inherent chemical capabilities be utilized, and in this



George S. Laaff

way in the full possibilities for the welding of extruded, molded or sheet parts be realized.

**Definition of "Unplasticized" and "Rigid" PVC**

Truly "unplasticized" PVC today is a purely theoretical phenomenon. The term "unplasticized" PVC is used in this paper, however, as the term "rigid" PVC would open the entire field to the use of so-called processing aids and other types of modifiers without violating the basic terminology; whereas, the word "unplasticized" PVC is much more specific and restricting. In a general way, commercial unplasticized PVC may be considered as a compound of substantially pure polyvinyl chloride resin in which only the minimum amount of stabilizer for processing stability is used. The optimum physical and chemical properties are obtained in unplasticized PVC.

"Rigid" PVC is the term applied to compounds which are substantially resin and stabilizer, to which modifying resins, fillers and often small amounts of plasticizers have been added. These modifications are usually made to improve processing properties. The processing aids or modifiers, added to the pure PVC resin, whether in polymerization or in subsequent compounding, will reduce the intermolecular attractive forces of the polyvinyl chloride and as such will change the physical and chemical properties from those of the pure resin. "Rigid" PVC will usually have lower physical and chemical properties than "unplasticized" polyvinyl chloride in corrosion resistant structural applications. A listing of the chemical resistance of unplasticized PVC toward aqueous inorganics is contained in combined table I and II. It can generally be said that resistance decreases with heat especially above 160 F.

The behavior of unplasticized PVC in contact with some of the organics is listed in Table I and II. It should be noted here that the resistance is non-existent toward some organics and doubtful toward others. Most aldehydes, ketones, esters, ethers, and chlorinated hydrocarbons will attack unplasticized PVC readily. Other organics cause less severe swelling but subsequent weakening. Long chain hydrocarbons and high hydroxyl content compounds have

## TABLES I AND II

### CHEMICAL RESISTANCE OF UNPLASTICIZED POLYVINYL CHLORIDE

| | 72°F | 140°F | | 72°F | 140°F | | 72°F | 140°F |
|---|---|---|---|---|---|---|---|---|
| Acetaldehyde | NR | NR | Boric acid | R | R | Dextrin | R | R |
| Acetic acid, 10% | R | R | Bromic acid | R | R | Dextrose | R | R |
| Acetic acid, glacial | R | NR | Bromine, liquid | NR | NR | Diazo salts | R | R |
| Acetic anhydride | NR | NR | Bromine, water | R | R | Diglycolic acid | R | R |
| Acetone | NR | NR | Butane | R | | Dimethylamine | NR | NR |
| Adipic acid | R | R | Butadiene | R | R | Dioctylphthalate | NR | NR |
| Allyl alcohol 96% | R | NR | Butanol, primary | R | R | Ethyl acetate | NR | NR |
| Allyl chloride | NR | NR | Butanol, secondary | R | NR | Ethyl acrylate | NR | NR |
| Alum | R | R | Butyl acetate | NR | NR | Ethyl alcohol | R | R |
| Aluminum chloride | R | R | Butyl phenol | R | NR | Ethyl chloride | NR | NR |
| Aluminum fluoride | R | R | Butylene | R @ 0°F | | Ethyl ether | NR | NR |
| Aluminum hydroxide | R | R | Butyne diol | R | NR | Ethylene bromide | NR | NR |
| Aluminum oxychloride | R | R | Butyric acid | NR | NR | Ethylene chlorhydrin | NR | NR |
| Aluminum nitrate | R | R | Calcium carbonate | R | R | Ethylene dichloride | NR | NR |
| Aluminum sulfate | R | R | Calcium chlorate | R | R | Ethylene glycol | R | R |
| Ammonia (gas) | R | R | Calcium chloride | R | R | Ethylene oxide | NR | NR |
| Ammonia (liquid) | NR | NR | Calcium hydroxide | R | R | Fatty acids | R | R |
| Ammonium bifluoride | R | R | Calcium hypochlorite | R | R | Ferric chloride | R | R |
| Ammonium carbonate | R | R | Calcium nitrate | R | R | Ferric nitrate | R | R |
| Ammonium chloride | R | R | Calcium sulfate | R | R | Ferric sulfate | R | R |
| Ammonium fluoride 25% | R | NR | Carbonic acid | R | R | Ferrous chloride | R | R |
| Ammonium hydroxide 28% | R | R | Carbon bisulfide | NR | NR | Ferrous sulfate | R | R |
| Ammonium metaphosphate | R | R | Carbon dioxide | R | R | Fluorine (gas) | R | R |
| Ammonium nitrate | R | R | Carbon monoxide | R | R | Fluorosilicic acid | R | R |
| Ammonium persulfate | R | R | Carbon tetrachloride | R | NR | Formaldehyde | R | R |
| Ammonium sulfate | R | R | Cellosolve | R | R | Formic acid | R | NR |
| Ammonium thiocyanate | R | R | Chloracetic acid | R | R | Fructose | R | R |
| Amyl acetate | NR | NR | Chloral hydrate | R | R | Furfural | NR | NR |
| Amyl chloride | NR | NR | Chloric acid 20% | R | R | Glucose | R | R |
| Aniline | NR | NR | Chlorine (gas) | R | NR | Glycerine | R | R |
| Aniline hydrochloride | NR | NR | Chlorine, water | R | R | Glycolic acid | R | R |
| Anthraquinone | R | | Chlorobenzene | NR | NR | Hexanol, teritiary | R | R |
| Anthraquinonesulfonic acid | R | R | Chloroform | NR | NR | Heptane | R | R |
| Antimony trichloride | R | R | Chlorosulfonic acid | R | | Hydrobromic acid 20% | R | R |
| Aqua regia | R | R | Chrome alum | R | R | Hydrochloric acid 35% | R | R |
| Arsenic acid 80% | R | R | Chromic acid 40% | R | R | Hydrochloric acid 10% | R | R |
| Arylsulfonic acid | R | NR | Citric acid | R | R | Hydrocyanic acid | R | R |
| Barium carbonate | R | R | Copper chloride | R | R | Hydrofluoric acid 48% | R | NR |
| Barium chloride | R | R | Copper cyanide | R | R | Hydrogen | R | R |
| Barium hydroxide | R | R | Copperfluoride | R | R | Hydrogen peroxide 90% | R | R |
| Barium sulfate | R | R | Copper nitrate | R | R | Hydrogen phosphide | R | R |
| Barium sulfide | R | R | Copper sulfate | R | R | Hydrogen sulfide | R | R |
| Benzaldehyde | NR | NR | Cresol | NR | NR | Hydroxylamine sulfate | R | R |
| Benzene | NR | NR | Cresylic acid 50% | R | R | Hypochlorous acid | R | R |
| Benzoic acid | R | R | Croton aldehyde | NR | NR | Iodine | NR | NR |
| Bismuth carbonate | R | R | Cyclohexanol | NR | NR | Kerosene | R | R |
| Borax | R | R | Cychlohexanon | NR | NR | Lactic acid | NR | NR |

(Continued on next page)

little or no effect on the unplasticized polyvinyl chloride.

Because it is very difficult to duplicate the actual conditions of some specific process, especially if borderline resistance may be expected, samples of unplasticized PVC should be placed in the corrosive media for long term contact. This is the most positive method of evaluation in cases where there may be some doubt as to whether unplasticized PVC is the proper material for a specific application.

In Table III are listed the more common physical properties of unplasticized PVC along with those of Polyethylene and Saran which are presently the more commonly known chemically resistant materials. There are some physical characteristics which must be borne in mind when designing structures of unplasticized PVC. All structural materials have some inherent problematical features, but their manifestations are more pronounced in the amorphous plastic materials. Such characteristics are troublesome only when they are unrecognized, and just as the flammability and swelling of wood or the heat conducting properties of metal have to be considered in design, so must the peculiarities of unplasticized PVC be compensated for in initial planning. Because of its tendency to creep under sustained load, unplasticized PVC will support a load equal to its normally reported tensile strength for only a matter of minutes. The permanent load which can be supported at 70-75°F is approximately 30-40% of this value.

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**TABLES I AND II (Continued)**

**CHEMICAL RESISTANCE OF UNPLASTICIZED POLYVINYL CHLORIDE**

| | 72°F | 140°F |
|---|---|---|
| Lard oil | R | R |
| Lauric acid | R | R |
| Lauryl chloride | R | |
| Lead acetate | R | R |
| Linoleic acid | R | R |
| Linseed oil | R | R |
| Magnesium carbonate | R | R |
| Magnesium chloride | R | R |
| Magnesium hydroxide | R | R |
| Magnesium nitrate | R | R |
| Magnesium sulfate | R | R |
| Malic acid | R | |
| Maleic acid | R | R |
| Mercuric chloride | R | R |
| Mercuric cyanide | R | R |
| Mercurous nitrate | R | R |
| Mercury | R | R |
| Methyl alcohol | R | R |
| Methyl chloride | NR | NR |
| Methyl ethyl ketone | NR | NR |
| Methyl sulfate | R | R |
| Methyl sulfuric acid | R | R |
| Methylene chloride | NR | NR |
| Mixed acid | R | R |
| Naphtha | R | R |
| Naphthalene | NR | NR |
| Nickel chloride | R | R |
| Nickel nitrate | R | R |
| Nickel sulfate | R | R |
| Nicotine | R | R |
| Nicotinic acid | R | R |
| Nitric acid, anhydrous | NR | |
| Nitric caid, 68% | R | R |
| Nitric acid, 10% | R | R |
| Nitrobenzene | NR | NR |
| Nitrous oxide | R | R |
| Oecnol | R | R |
| Oils & Fats | R | R |
| Oleic acid | R | R |
| Oleum | NR | |
| Oxalic acid | R | R |
| Ozone | R | R |
| Palmitic acid | R | R |
| Perchloric acid 70% | R | NR |
| Perchloric acid 10% | R | NR |
| Phenol | R | NR |
| Phenylhyrazine | NR | |
| Phenylhyrazine Hydrochloride | R | NR |
| Phosgene, liquid | NR | |
| Phosgene, gas | R | |
| Phosphoric acid 85% | R | R |
| Phosphoric acid 10% | R | R |
| Phosphorus (yellow) | R | |
| Phosphorus pentoxide | R | |
| Phosphorus trichloride | NR | |
| Picric acid | NR | NR |
| Potassium bicarbonate | R | R |
| Potassium bichromate | R | R |
| Potassium borate | R | R |
| Potassium bromate | R | R |
| Potassium bromide | R | R |
| Potassium carbonate | R | R |
| Potassium chromate | R | R |
| Potassium chlorate | R | R |
| Potassium cyanide | R | R |
| Potassium ferricyanide | R | R |
| Potassium ferrocyanide | R | R |
| Potassium fluoride | R | R |
| Potassium hydroxide | R | R |
| Potassium nitrate | R | R |
| Potassium perborate | R | R |
| Potassium perchlorite | R | R |
| Potassium permanganate 10% | R | R |
| Potassium persulfate | R | R |
| Potassium sulfate | R | R |
| Propane | R | |
| Propargyl alcohol | R | R |
| Propyl alcohol | R | R |
| Propylene dichloride | NR | NR |
| Selenic acid | R | |
| Silicic acid | R | R |
| Silver cyanide | R | R |
| Silver nitrate | R | R |
| Sodium acetate | R | R |
| Sodium benzoate | R | R |
| Sodium bicarbonate | R | R |
| Sodium bisulfate | R | R |
| Sodium bisulfite | R | R |
| Sodium bromide | R | R |
| Sodium carbonate | R | R |
| Sodium chlorate | R | R |
| Sodium chloride | R | R |
| Sodium cyanide | R | R |
| Sodium ferricyanide | R | R |
| Sodium ferrocyanide | R | R |
| Sodium fluoride | R | R |
| Sodium hydroxide | R | R |
| Sodium hypochlorite | R | R |
| Sodium nitrate | R | R |
| Sodium nitrite | R | R |
| Sodium sulfate | R | R |
| Sodium sulfide | R | R |
| Sodium sulfite | R | R |
| Stannic chloride | R | R |
| Stannous chloride | R | R |
| Stearic acid | R | R |
| Sulfur | R | R |
| Sulfur dioxide (gas) | R | R |
| Sulfur dioxide (liquid) | R | NR |
| Sulfur trioxide | R | R |
| Sulfuric acid 94% | R | R |
| Sulfuric acid 80% | R | R |
| Sulfuric acid 33% | R | R |
| Sulfurous acid | R | R |
| Tannic acid | R | R |
| Tartaric acid | R | R |
| Tetraethyl lead | R | |
| Tetrahydrofurane | NR | NR |
| Thionyl chloride | NR | |
| Toluol | NR | NR |
| Tri Butyl Phosphate | NR | NR |
| Trichloroethylene | NR | NR |
| Triethanolamine | R | R |
| Triethylamine | R | R |
| Trixiethyl propane | R | R |
| Trisodium phosphate | R | R |
| Turpentine | R | R |
| Urea | R | R |
| Urine | R | R |
| Vinyl acetate | NR | |
| Zinc chloride | R | R |
| Zinc sulfate | R | R |
| Bleach 12.5% active Cl | R | R |
| Breeder pellets (deriv. fish) | R | R |
| Fish solubles | R | R |
| Fruit juices + pulp | R | R |
| Gasoline | R | R |
| Liqueurs | R | R |
| Molasses | R | R |
| **Photographic solutions** | | |
| D. K. #3 | R | R |
| Dektal Developer | R | R |
| Kodak Fixer | R | R |
| Kodak Short Stop | R | R |
| Rayon coagulating bath | R | R |
| Sea water | R | R |
| Silver plating solution | R | R |
| Tanning liquors | R | R |
| Wines | R | R |

TABLE III

PROPERTIES OF UNPLASTICIZED P. V. C.

| | ASTM Method | Unplasticized PVC | Polyethylene | Saran |
|---|---|---|---|---|
| Specific Gravity | D792-48T | 1.4 | .9 | 1.7 |
| Tensile Strength p. s. i. | D638-49T | 8500 | 2500 | 5000 |
| Modulus of Elasticity in Tension - p. s. i. | D638-49T | $4\text{-}5\times10^5$ | $2\times10^5$ | $0.8\times10^5$ |
| Flexural Strength - p. s. i. | D671-49T | 16,000 | 1700 | 16,000 |
| Compressive Strength - p. s. i. | D695-49T | 10,000 | – | 8000 |
| Hardness (Rockwell) | D785-48T | M-60 | R-11 | M-60 |
| Heat Distortion °F - 66 p. s. i. (Maximum Useful Temperature) | D648-45T | 165°F | 120°F | 160°F |
| Coeficient of Expansion per 1°C | D694-44 | $8\times10^{-5}$ | $4\times10^{-4}$ | $16\times10^{-5}$ |
| Thermal Conductivity Cal sec cm² cm/°C | C-177 | $4\times10^{-4}$ | $8\times10^{-4}$ | $3\times10^{-4}$ |
| Specific Heat Cal gm °C | Calorific Method | .24 | .55 | .32 |
| Flammability | D568-48 | Self Ext. | Burns | Self Ext. |
| Dielectric Constant @ 1 megacycle | D150-47T | 3 | 2.3 | 4 |
| Water Absorption % 24 hrs. @ 25°C | D570-42 | .05 | .01 | .05 |

These values should be considered conservative since recent tests on improved resins indicate that higher values for permanent load will be confirmed. It has been found that permanent load values will fall uniformly with temperature increases until at 165-170°F this permanent load is practically zero. This characteristic of unplasticized PVC is not unlike that of metals where such phenomena also occur. They differ in that the temperature ranges of applications for unplasticized PVC are much lower.

Notch brittleness is another important physical characteristic which must be considered. Sharply angled joints and deep grooves should be avoided. In some cases unusually heavy cross sections or other structural deviations will have to be used in order to guard against notch weakness. The engineer must always bear in mind the thermoplastic nature of the material and must design accordingly.

Upon logically considering the excellent corrosion resistance and fabrication possibilities of unplasticized PVC, however, it will be realized that there are very many uses to which it may be applied most advantageously.

Unplasticized PVC is available for fabrication in the form of sheets from 1/32" through 1" and as tubing and pipe from ¼" through 6". It can also be obtained as bar stock both round and hexagonal, as solid blocks for heavy cross sections and also in the form of welding rod. Molding compounds are available for transfer molding into standard pipe fittings such as 45° and 90° elbows, couplings, tees, unions, caps, plugs, flanges and other types of joints.

These shapes may be fabricated into many structures where chemical inertness is of prime importance. Fume hoods and ducts in combination with fans and blowers are being made of unplasticized PVC. Many examples of its use in several specific industries will serve to illustrate its wide range of possibilities.

1. Textile Industry
   a. Fume tunnels 100' - 160' in length and 8' - 12' in cross section.
   b. Inspection doors and frames for tunnels.
   c. Humidification equipment.
   d. Vacuum soak carrier units.
   e. Pipes, valves and fittings.
2. Electroplating Industry
   a. Plenum chambers.
   b. Vats and tanks.
   c. Fume systems.
   d. Hoods.
   e. Pipes, valves and fittings.

The heavy chemicals, photographic film, paper, food, and dairy industries are almost daily finding new uses for unplasticized PVC in their processes. Wherever the important characteristics of a structural material must be high corrosion resistance and non-contamination, this material fills a definite role. A more complete listing of industries and applications is given in Table IV.

## WELDING

The method of fabrication offering the widest range of applications and extending the possible size of installations almost infinitely is that of hot-gas welding. Much of the art of early hot-gas welding has now been resolved into widely accepted concepts. The present day hot-gas welding torch consists of a coiled tube, heated by a gas flame or a resistance coil, through which passes the welding gas, usually compressed air or an inert gas such as nitrogen. By varying the size of the flame or the resistance and/or the volume of the inert gas, the temperature of the issuing hot gases may be varied over a wide temperature range. For welding unplasticized PVC, temperatures of 475°F - 550°F are normally used.

The welding of unplasticized PVC is essentially the same as the electric-arc welding of metals in regard to the preparation of the pieces to be welded. The main difference is in the type of joining which takes place. While complete fusion of the rod and stock takes place in metal welding, with a thermoplastic such as unplasticized PVC, a simple bonding takes place between the contacting surfaces of the rod and stock. A slight pressure applied to the rod in the process, forces the two melted surfaces together, producing a homogeneous weld.

To obtain uniformly good welding, the area to be welded as well as the rod must be sufficiently preheated by the hot-gas jet before being forced into the weld bed. Too little heat results in a poor bond while overheating may cause the material to decompose.

When proper techniques are followed, weld values may be obtained which will normally be 85% of the tensile value of the base material, and often the tensile strength of the weld is greater than the sheet. The impact strength in the vicinity of the weld is reduced.

Proper welding must be considered the most important element of fabrication. An intensive training course is an absolute necessity for producing expert plastic welders.

The metal welder's hand would appear too heavy and perhaps only a few of the techniques which he has developed to the point of habit would appear of value in welding uplasticized PVC. His experience, however, will quickly prove invaluable in acquiring the new plastic welding techniques. On the other hand, a person completely unfamiliar with metal welding, with proper aptitude and training, should develop into a good plastic welder. It is generally believed that the continuous, accurate and delicate routine operation of plastic welding will find women better suited than men.

The performance of each plastic welder must be checked periodically. Actual physical tests of sample specimens are the most positive method of arresting the development of bad practices and sub-standard weld values. The experience of German fabricators of unplasticized PVC has shown that periodic performance tests of plastic welders maintained and improved weld values, while unchecked welders' performance was 25% to 50% below optimum results. To further the exchange of information and experience, German technical schools, supported by industry, have established departments for the fabrication of plastics. These schools are open to engineers, technicians, and mechanics.

Unplasticized polyvinyl chloride may be shaped in fabrication by slight modifications of the common molding

FIGURE I

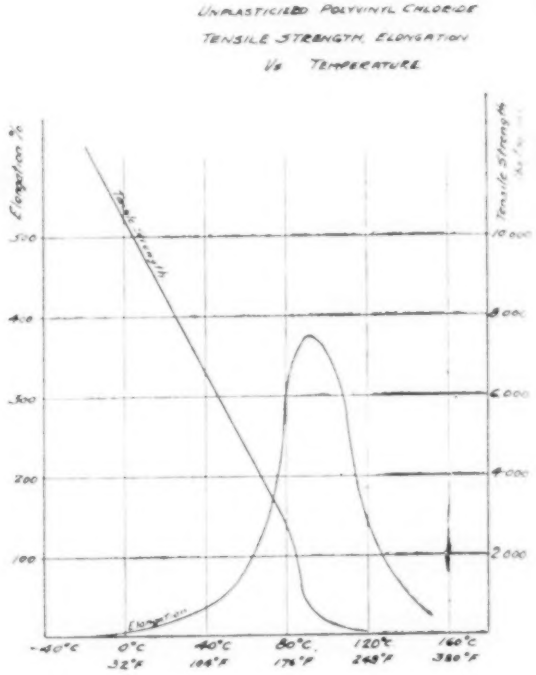



**TABLE IV**

**Industries and Applications Concerned with Corrosion Resistant Materials**

**Industries**

1) Agricultural Chemical Ind.
2) Atomic Energy Plants
3) Automotive Industry
4) Battery Industry
5) Breweries
6) Construction Industry
7) Dairies
8) Fermentation Industry
9) Food Processing Industry
10) Gas Processing Industry
11) Glass Industry
12) Laboratory Equipment Industry
13) Marine and Fish Industry
14) Mining and Smelting Industry
15) Paper and Pulp Industry
16) Electroplating, Anodizing and Related Industries
17) Oil Industry
18) Rayon Industry
19) Sewage Disposal Plants
20) Steel Industry
21) Synthetic Fiber Industry
22) Tanneries
23) Textile Industries
24) Water Treatment Plant
25) Ventilating & Air Conditioning

**Applications**

1) Absorption Apparatus
2) Agricultural Spraying Equipment
3) Agitators
4) Bearings
5) Bleaching Equipment
6) Bottles
7) Cans
8) Centrifugal Pumps
9) Cooling Systems
10) Cooling Coils
11) Dipping Baskets
12) Dust Arrestors
13) Exhaust Fans
14) Filters
15) Floats
16) Fume Ducts and Tunnels
17) Fume Hoods
18) Fume Stacks
19) Gas Meters
20) Gears
21) Humidification Equipment
22) Intermediate Printing Blades
23) Insulators
24) Laboratory Equipment, Tables, Sinks
25) Nuts and Bolts
26) Pharmaceuticals
27) Plating Barrels
28) Plenum Chambers
29) Pumps
30) Reaction Tanks
31) Raction Towers
32) Scoops
33) Sizing Troughs & Vats
34) Splash Covers
35) Spinnerette Adaptors
36) Strainers
37) Suction Fans
38) Switch boards
39) Switch Insulators
40) Tanks
41) Tank Liners
42) Trays
43) Transparent windows
44) Valves
45) Ventilators
46) Wire Insulation

techniques used in the plastics industry. Shallow forming may be effected on thin sheets by the vacuum method. The molds may be made inexpensively of wood, masonite or aluminum. A vacuum of 17-25 inches of mercury is sufficient to mold sheets up to $\frac{1}{8}$" thickness. The material is heated to 215°F (cf Elong temp curve Fig. I) in an oven and is then quickly placed on the mold. A sealing frame is lowered, and the vacuum is applied. This suction is maintained until the stock cools somewhat, and then the molded piece is removed and after complete cooling is trimmed on a saw, router or shear.

Where moldings are made of thicker materials or where deeper draws or sharp curves are required, the "plug and ring" mold, illustrated in Figure II may be used. The sheet, heated as in vacuum molding, is placed in the mold. The forming plug is lowered until the pressure ring grips the sheet edges. The plug then continues downward pressing the sheet into the mold contour.

For intricate shapes and heavy cross-sections, the transfer molding technique is followed. Pipe fittings and

FIGURE II

Plug and Ring Mold for Thick Sections

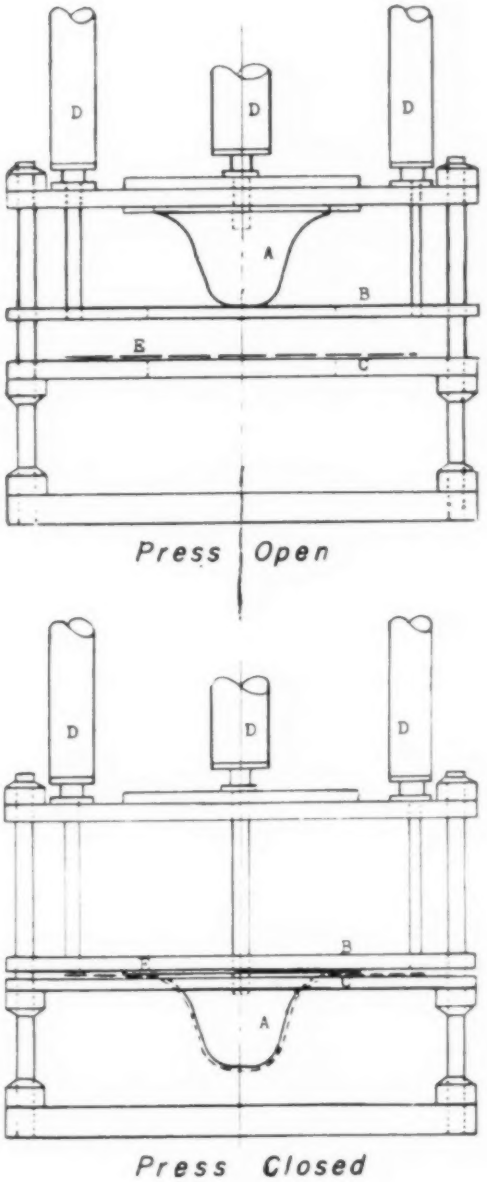
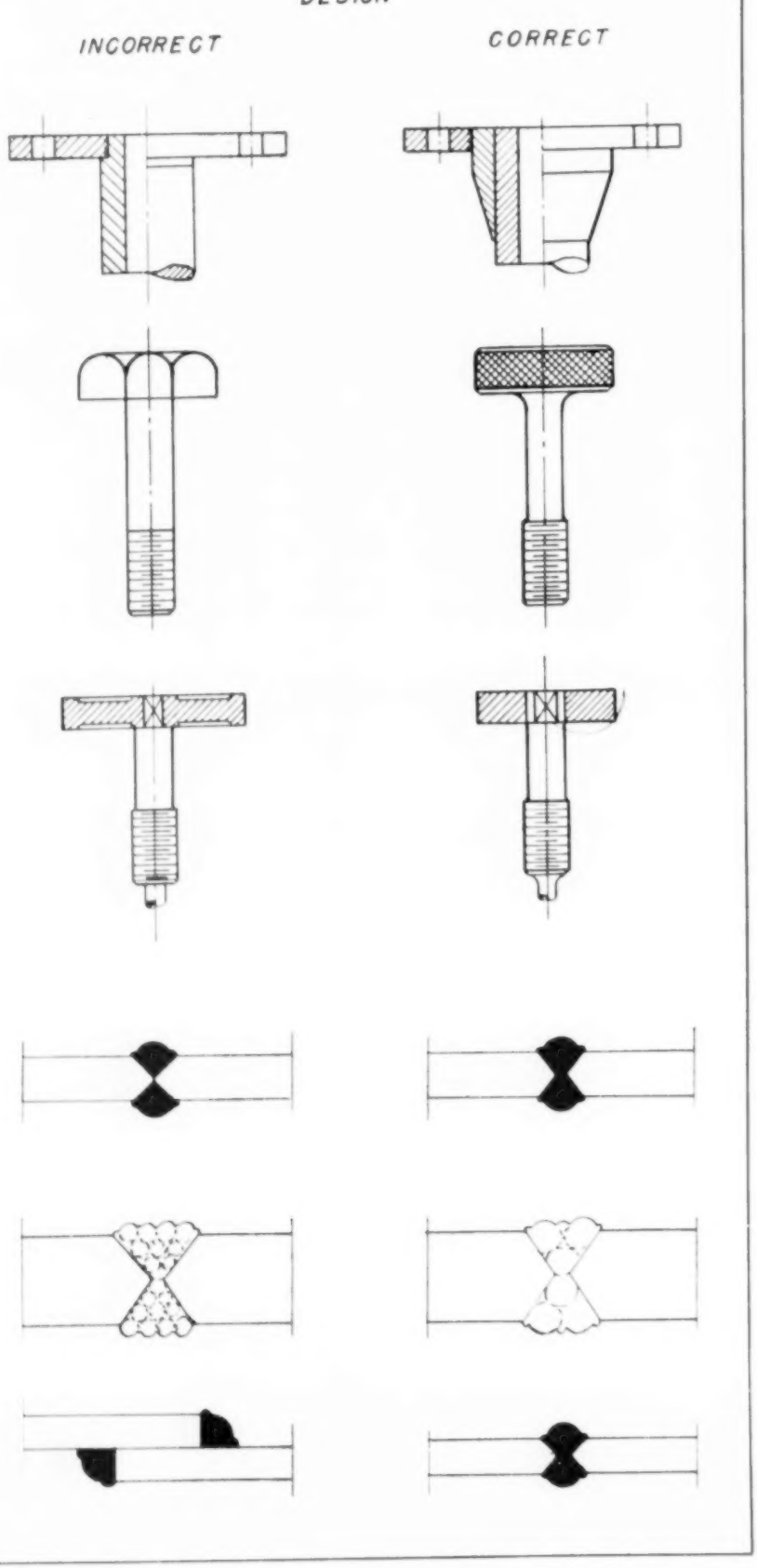



TABLE V

SOME EUROPEAN UNPLASTICIZED P.V.C. INSTALLATIONS

| Application | No. Years of Satisfactory Service |
|---|---|
| **HCl** | |
| 6" piping handling HCl gas - outdoors | 5 |
| $2\frac{1}{2}$" pipe line, conc. HCl - outdoors, HCl prod. unit | 17 |
| 20" duct, 300' long, HCl gas - outdoors, HCl prod. unit | 10 |
| 3" piping & valves, HCl prod. unit outdoors | 10 |
| **$H_2SO_4$** | |
| Storage Tank, 15% $H_2SO_4$ | 13 |
| Piping & duct work in $H_2SO_4$ prod. unit | 13 |
| **HNO** | |
| Exhaust ventilators for gas, 12,000 cu. meters min. | 7 |
| **Cl** | |
| Gas at 158°F - 2" pipe, 3/16" wall | 4 (sl. attack) 20% destroyed |
| **Electroplating Plants** | |
| Galvanic, tanks & piping | 6 |
| **Photographic Industry** | |
| Development tanks & trays | 5 |
| **Leather Tanning** | |
| Piping & containers | 4 |
| **Paper Production** | |
| Tanks & Piping | 4 |
| **Water Treatment** | |
| Chlorination tanks & piping | 3 |
| Containers for ion exchange resins | 3 |
| **Soap Industry** | |
| Soap storage tank | 4 |
| **Pharmaceutical Chem. Mfg.** | |
| Piping, duct work | 2-6 |
| **Organic Color Mfg.** | |
| Piping, duct work | 6 |
| **Agricultural Chemicals** | |
| Piping, ventilator fans | 2-6 |
| **Oil Refineries** | |
| Piping | 3-6 |
| **$H_2O_2$** | |
| Rotary Filter 6' x 8' | 4 |
| **HF Gas** | |
| 3' dia. duct work, 3/8" thick, 100' long | Being installed |
| **$SO_2$ Gas** | |
| Piping & valves, 3" dia. | 5 |
| **NaOH** | |
| Piping & valves | 2 |
| **Phthalic & Maleic Anhydride** | |
| Piping, ventilator fans in prod. plant | 2 |
| **Textile Industry** | |
| Pulley - 6" dia., 1/8" cover (dil. $H_2SO_4$) (6 of 60,000 failed) | 3 |

FIGURE III—Some correct and incorrect designs for unplasticized PVC parts.




similar parts are produced by this method. Weighed charges of unplasticized polyvinyl chloride are heated and then placed in the transfer pot or cylinder. The transfer piston moves downward under pressure and forces the hot material through an orifice into the steel mold itself. The mold is then cooled and the piece is removed. Because of high mold costs, this method of fabrication is usually used in making those shapes which are complex and which are used in great quantities.

Unplasticized PVC may readily be machined on the common wood and metal working tools. There are some slight modifications and precautions which must be observed, but the adaptation of skills and tools to shaping this material is not difficult. (Saws should have little or no set.)

This material may be sawed, cut, turned, milled, bored, punched, and polished. Cutting speeds are similar to those used for light metals. Unplasticized PVC is a poor heat conductor, however, and efficient cooling must be provided to prevent localized melting of the stock.

How closely an installation of a specific unplasticized PVC will approach its theoretical possibilities in any application is dependent upon two factors: basic materials and fabrication. The first factor, most critical and perversely the more difficult to detect, is concerned with the chemical and physical makeup of the material itself.

Because unplasticized vinyl resin is difficult to process by itself, the converter may incorporate a variety of other compounds to aid the material in attaining the shape desired. Whether the material is "Vinyl" sheet rod or pipe when it is received by the fabricator is dependent upon the adherence of the converter in his formulation to that basic conception of "as near 100% resin as possible."

The chemical suitability of a particular material may be established subjectively by a direct quantitative analysis of a representative sample. This approach is slow and expensive. A wide group of chemical resistance tests will serve to indicate whether the particular type of "unplasticized" PVC has been dangerously modified if the results are at wide variance to those reported in Tables I and II. The objective approach is to introduce the sample of unplasticized polyvinyl chloride to some of the material with which contact is being contemplated preferably at a slightly higher temperature than that at which it will be used, and to measure weight changes for 1 to 2 months. If the change in weight is small initially and rapidly approaches zero, the material is chemically suitable to the application. Determination of the heat distortion point by ASTM 648-48T will give

(Please turn to page 36)

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# *Molds* ACCURATELY DUPLICATED FROM MASTER PATTERNS ON DIE SINKING MACHINES

In Keller machines like the one shown—one of a battery in use at Newark Die—a tracer passing over a master pattern automatically controls the movements of the feeding mechanism, which in turn governs the cutting of the mold.

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# Changes In Cross-Section On Extrusion

Zvi Rigbi

*B.Sc. (Eng.), Ph.D., G.I. Mech. Eng.*
*Rehovot, Israel*

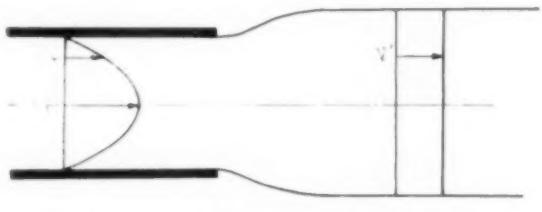

Fig. 1. Swelling on emergence from a tube. The parabolic velocity distribution is transformed into a uniform velocity as the result of internal forces only.

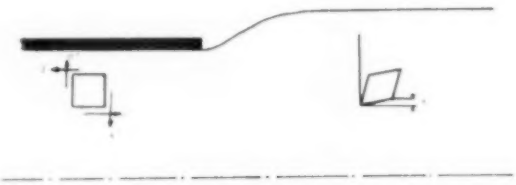

Fig. 2 (a). Elementary cube of material subject to shearing stresses $\acute{O}$ and to complementary stresses $\acute{O}' = \acute{O}$.
(b). Elementary cube of material relieved of the stresses shown in (a).

**Notation**

v—velocity at any point in tube at distance r from axis
V—maximum velocity in tube
V'—uniform velocity of stream after emergence
R—radius of tube
r—radius from axis to any point in fluid
$\sigma$—shearing stress
$\eta$—viscosity
G—modulus of rigidity (elasticity in shear)
$\tau$—relaxation time $= \eta$ G
$\varepsilon$—shear strain
$\psi$—firmness
S—total swelling
S'—proportional swelling $= S/2R$
$\Delta p/l$—pressure gradient
l—length of tube

A NUMBER OF AUTHORS [1,2] have noted the change of diameter of a fluid stream upon emergence from a tube, and this has often been explained away as an effect of "bulk elasticity." Thus, Richardson[2], who reproduces two excellent photographs, writes "Evidently, under the influence of the pressure used to force it *(the fluid, in this case a solution of rubber in toluene§)* through the tube, it had contracted on entry and relieved itself of this compression on leaving the tube."

Apart from the fact that the observed swelling varies between wide limits for fluids whose bulk moduli are not greatly different, this conception of swelling can be criticised from two viewpoints:

If the statement quoted above is examined closely, it will be understood to imply that the pressure acting on the fluid is discontinuous at the orifice along the stream lines, since the pressure is said to be finite before emergence and must vanish immediately after it. While the present writer has no proof that this is not the case, it is felt that such a discontinuity, and the discontinuity of velocity derived from it by energy considerations, present a rather unusual physical picture.

Furthermore, due to the fact that the swelling develops only some distance from the end of the tube, the assumption of an instantaneous relief of pressure necessitates the assumption of a retardation in the elastic movements involved in bulk straining. While this is possible, no authority has been found for believing that the elastic changes of volume due to changes of hydrostatic pressure are anything but instantaneous.

The following explanation is proposed for the phenomenon. During flow through a tube, the fluid is subject to shearing stresses in the axial direction. In addition to these, shearing stresses (called complementary stresses) act in the radial direction[3]. Considering, for the time being, only Newtonian fluids, we may write the velocity at any point as

$$v = V\left(1 - \frac{r^2}{R^2}\right)$$

The shearing stresses, both axial and radial, are then

$$\sigma = \eta \frac{dv}{dr} = -2\eta \frac{Vr}{R^2}$$

The negative sign will be neglected in the following discussion, indicating as it does only a direction.

As the material leaves the tube, a gradual rearrangement of velocities within the material takes place until

§ *Authors italics*

the velocity is uniform on the cross-section and the shearing stresses vanish. During this interval, an elementary cube of material is deformed (or rather, "deformed back") from shape (a) to shape (b) shown in Fig. 2., the effect being due to rigidity or elasticity in shear. Swelling can be observed with a wide range of mobile fluids, and it is interesting to note that Kendall[4] has developed an elegant method by means of which he detected rigidity in many fluids. The present writer believes that a refinement of Kendall's technique will be able to detect and measure rigidity in all but the most mobile fluids.

The elementary radial strain is

$$\varepsilon = \frac{\sigma}{2G} = \frac{1}{2} \cdot \frac{2Vr}{R^2} \cdot \frac{\eta}{G} = \frac{Vr}{R^2}\tau$$

the factor $^1/_2$ being due to the rotation of the element. If this is summed up along the diameter, we obtain the total swelling as

$$S = \int_{-R}^{R} \varepsilon dr = \frac{V}{R^2}\tau \int_{-R}^{R} r dr = V\tau = \frac{2Q}{\pi R^2}\tau$$

and

$$S' = \frac{S}{2R} = \frac{V}{2R}\tau = \frac{Q}{\pi R^3}\tau$$

$$V' = V\frac{1}{2\left(1+\frac{V\tau}{R}\right)^2}$$

These two expressions may also be written as follows; in this form, the swelling of plastic (Bingham and Ostwald-de Waele) materials, for which the velocity distribution is flatter, is seen to depend on the pressure gradient, the diameter of the tube and the rigidity of the material.

$$S = \frac{\Delta p}{l} \cdot \frac{R^4}{G}$$

$$S' = \frac{\Delta p}{l} \cdot \frac{R}{G}$$

By an extension of the expressions derived by Dexter and Dienes[5], the swelling of a material obeying the Nutting-Scott Blair power law[6] can be written as

$$S = \frac{2}{k}\left(\frac{V\tau}{2}\right)^k \cdot l^{1-k}$$

which reduces to the expressions previously obtained when k becomes unity. It is interesting to note that as the length of the tube increases, the swelling of such materials increases although at a much slower rate.

It must be stressed that the above results are purely theoretical, and that no data have been found to support or reject these conclusions.

### References


1. *Merrington*, 1943, Nature, *152*, 663
2. *Richardson, E. G.*, 1945, Endeavor *4*, 14, 65
3. *Reiner, M.*, 1949, Deformation and Flow, (London) P. 7 states and proves that "tangential tractions on interfaces at right angles to each other are equal."
4. *Kendall*. The reference to this paper, published before 1943, and probably between 1936 and 1938, has been lost. The writer will be grateful for any assistance given in bringing this paper out of the ill-deserved obscurity into which it has fallen.
5. *Dexter, F. D.* and *Dienes, G. J.*, 1950, Jour. Colloid Sci., *5*, 3, 228
6. *Scott Blair, G. W.*, A Survey of Theoretical and Applied Rheology (London)



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# Successful Designing for Plastics Molding

W. M. Halliday

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GENERALLY, rib features of the kind already illustrated and described in this series of articles will materially assist the mold designer and engineer to obtain a more satisfactory component, by affording a simple yet inexpensive means for increasing strength and rigidity. By their use, slender or relatively weak and unsupported cored-out wall sections may be supported or stiffened in such a manner as to render them less liable to warpage and distortion.

With the judicious distribution of ribs of the correct design form, the ejection of the component may be facilitated, and this critical operation safely accomplished without delay or inflicting distortion or injury upon the part. The correct use of these features will also often lead to considerable savings in actual molding material, because it will not be necessary to thicken up the walls generally, as would otherwise be the case if ribs were not employed.

Ribs tend to reduce or prevent undesirable stressing at critical points, thus obviating the tendency towards cracking, or serious loss of shape and size.

Ribs also help to radiate mold heat more uniformly over the important cavity areas, thereby assisting to eliminate unequalized shrinkage of the part and the resultant distortion of slender walls.

They also enable the mold engineer to exert a better control over the direction of material flow in the mold cavity. This will be especially important when using injection molds where the material is very often injected in almost a fluid state.

### Beadings

Very closely allied to the rib is the similar element known as the beading. Essentially this commonly used design feature will act very much like the rib; in many instances one may be used in place of the other with equal facility and success.

The beading, however, has certain particular applications and special uses which cannot be fulfilled by the rib, i.e., it is very extensively employed as a means for improving the appearance of a finished component, and to enhance some external surface of the part. Beadings are generally situated upon some outside and visible surface or edge of the component, whereas ribs are usually located within some cored opening of the component, and thus will not be in sight when the piece is normally engaged under service conditions.

Beadings are, of course, widely adopted as a means of both improving appearance and strengthening certain portions of the component wall. For example, where the wall of a molding has to be cored out to such a degree as will leave the remaining section weak and liable to deflect under load, a beading often of very small size may be disposed around the external edges of the cored opening. Instances arise with such coverings where it is not practicable to embody ribs on the interior walls, and thus beadings may offer the only practical means for strengthening such parts.

Beadings are also introduced into a component design to relieve or "break" large flat surface areas, which otherwise would be uninteresting in appearance value.

Yet another valuable use for beadings is to facilitate or simplify trimming operations on the component after leaving the mold when parting-line flash has to be removed. This will be accomplished by providing and locating the bead so that it will lie around the component coincident with the mold block parting plane, and thus along the line of greatest flash.

Such a bead may be positioned so that the flash would occur either at one edge, or at the crest thereof, rendering its removal much simpler and safer. Where straight, plain flat surfaces have to be trimmed for parting-line surface flash, there will always be some danger of accidentally inserting the component slightly out of line with the die, and so shearing into the highly polished plain surface at one side of the component, whose appearance would thus be completely marred.

By having a beading of only a very small height at the parting line around the component, the remaining flat wall surfaces will be well clear of the cutting edges of the trimming or shearing die, so obviating the kind of damage mentioned above.

The use of beadings may also prove extremely helpful to the mold designer by allowing him very readily to ensure that the solidified component will always adhere to one mold block, usually the movable member. Whilst this need often arises with the use of compression molds, it is of critical importance generally with injection-type molds, since the ejector mechanism has to be installed on the movable

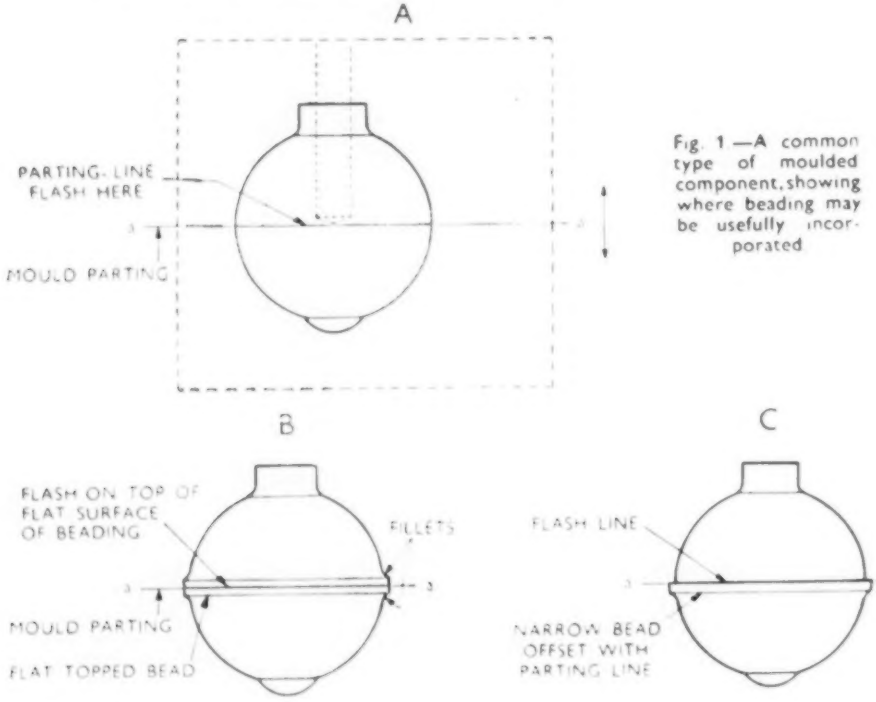


Fig. 1—A common type of moulded component, showing where beading may be usefully incorporated

block and therefore the component must be drawn out of any cavity portion in the stationary block, when the tool is opened. Failure, or difficulties in this respect, may lead to serious troubles when ejecting the component. Externally located beadings can also sometimes be used advantageously, where, because of the complex configuration, or unusual shape of the article, ribs cannot be employed on the internal surfaces.

In some cases difficulties arise when machining rib channels or cavities in the mold. These may occasionally be of such a magnitude as to lead the designer to adopt beadings at other suitable points in place of the proposed ribs.

Beadings are also employed to improve the handling qualities of a component, for example, numerous types of domestic ware, and containers, which have to be fitted with screw-on or tight-fitting sealing covers and caps. With such articles, especially if of plain cylindrical tubular shape, it will be highly desirable to break the "smooth," round external surfaces of both container and cover by means of shallow beadings, steps or grooves (i.e., reverse beadings) so that the user may obtain a smarter grip of both members.

In this same connection beadings are often employed to remove sharp edges and corners which otherwise would render the handling of the article very uncomfortable.

Beadings, too, can be used very successfully to mask minor surface blemishes, such as "sinks," flow lines, slight distortion and similar irregularities impairing the appearance value in cases where such defects are unavoidable owing to the general design of the article.

### Examples of the Design and Use of Beading

To illustrate more clearly the numerous useful ways in which beadings may be advantageously employed, a number of examples will now be considered.

These will not only be indicative of the various forms and shapes of beading available and the manner of their application, but will also illustrate the preferred design forms to be used to meet any specific requirement, viz., whether the beading is required solely to improve appearance or as a combined decorative and utilitarian feature, or to increase the strength of the component.

Fig. 1 depicts a very common type of molded component where beading may often be usefully incorporated. This kind of article will usually be made by compression using a thermosetting material.

The component A (Fig. 1) is actually a spherical knob having a short, hollow cylindrical boss portion formed integrally at one side. This boss extension is to be cored out for a fixing hole by means of which the knob may be affixed to a handle, rod, etc.

To produce such a knob will require the mold having its main parting plane located across the diameter of the part at right-angles to the axis of the cored hole in the boss, such a parting being denoted by line a—a. The respective mold blocks are shown in light broken lines, and the direction of their normal parting movement is indicated by the arrow at the right.

The upper mold block is the movable member and contains a cavity exactly one-half of the spherical shape of the knob, together with the cavity for the boss extension. This member also carries the stationary core plug for hollowing out this boss. The ejector plug or other mechanism will also be mounted within this moving block.

The lower (fixed) block will contain only one-half of the spherical cavity formation, disposed so as to match up exactly around its periphery with the cavity formation contained in the upper mold block.

Thus a knob of the design shown would be produced with a flashing along line a—a, extending completely round the maximum diameter of the part as shown. No beading is employed with this design and, therefore, the following objections could be expected in respect of the finished component.

Removal of the parting-line flash would present certain practical difficulties since the part would have to be mounted upon a revolving spindle and the flash pared off by means of a sharp cutter. Alternatively, the knob could be pressed through a conventional type trimming die to shear off the excess flash and material.

With each of these methods there would be considerable risk of cutting or shearing into the smooth, polished surface of the ball portion immediately adjacent to the flash line, and in any event, an unsightly scar or marking would probably remain after such flashings had been removed.

Furthermore, unless the cavity portions in the respective mold blocks were very accurately matched up and maintained in correct alignment, the two halves of the spherical knob would be molded in an off-set manner. The resulting projections at each side of the knob would then seriously detract from the appearance and smooth "feel" of the article. To remove such overhanging projections, etc., would entail a heavy trimming operation, which would be accomplished only at the risk of destroying or impairing the true spherical shape of the molding.

The much-improved design shown at B (Fig. 1) is attained very simply by the introduction of a small beading at this critical parting-line point, and the use of this will materially diminish the undesirable feature observed with example A.

This modified knob component would, of course, be produced in the mold in exactly the same way as with the previous example, the only alteration to the mold being the provision of an enlargement of each cavity portion in the respective blocks.

The diameter of each cavity would be enlarged at the parting-line surface of the block, making these portions exactly the same outside diameter and depth, so that one-half of the width of the beading would be formed in each block. The mold parting line a—a would thus lie around the centre of the flat-topped beading, as shown in the diagram.

The flash formed during molding would occur along this same line (see heavy black line), and so would be capable of being easily removed by means of an ordinary type of punch-die, plate-shearing or trimming tool.

It should be specially noted that each side of this bead is blended to the curvature of the spherical knob by a small-radius fillet. Such a provision will enhance the appearance of the part. If desired, the sharp corners of the bead at each side should be gently broken either by leaving a small radius in the mold cavity itself, or at a later polishing and buffing stage. This would make the knob more comfortable to grasp during use. To a useful degree, any scar resulting from the trimming of the parting-line flash will be masked by the flat surfaces of the bead.

On the other hand, the crest of the beading could be more heavily machined, sheared, or polished to produce a perfectly smooth, unbroken surface, without incurring the risk of spoiling the polished spherical surfaces of the knob.

Another alternative form of beading the same knob component is shown at C (Fig. 1). This is almost equally as effective as example B, and possesses the merit of being even less expensive to reproduce into the mold.

It will be noted that this form of beading is made much narrower in width than with the preceding example and, moreover, it is located only at one side of the parting line a—a. This requires only one enlargement to be made to the mold cavity, viz., that in the (lower) stationary mold block.

The shape of this beading is somewhat different, too. It is flat on the crest, but this portion is not made parallel in diameter as before; instead, the crest is amply tapered about 10 degrees per side. A small radius fillet blends the side of the beading to the curvature of the knob.

Any flash occurring during molding will thus be situated along the sharp top edge of the beading, and it would be preferable to remove this by means of a slightly concave form-cutting tool fed into the knob in such a manner as to remove the sharp corner and flash at the top edge of the bead.

One great advantage possessed by

(Please turn to page 34)

# THE *Injection* MOLDERSCOPE

By A. R. Morse

*President, Injection Molder's Supply Co.*

**WEST COAST NOTEBOOK:—**

Battling incredible smog and incredible traffic to visit Burroughs Mfg. who pioneered thermoplastic housewares. To lighting Specialties—one of the cleanest, sweetest injection molding operations you will ever see, with one pneumatic hoist feeding several presses. Two plants would not let us in. This means their operation is very far behind competition or very far ahead of it—hard to decide which. Observed Bob Dykehouse's (Conso Tool) creditable efforts to perfect a compact preplasticizer. A full scale prototype now being built for testing on the Reed 8. Postpone any conclusions till the unit is actually built. At Gowland Creations (those fancy ship and auto model sets) again as nice, as orderly, as clean an injection operation as you will ever see—a battery of nearly a dozen Lewis machines under Jack Bromley who has just started up their new Puerto Rico plant. The Lewis presses working to perfection on shots within their actual range. At Pacific Products—a big battery of Impcos producing a line of quality ware under Bob Greenhood. Confess I was surprised when Bob showed me a light signal on a 22 oz. machine—a signal to the operator to **wait** between cycles till the heater caught up with the job! Thought of Oran Wilson's signal lights at Wilson Plastics in Sandusky, Ohio, which signal when die is open **too long** between cycles—just the opposite idea. More fog and traffic, with the West Coast ever more attractive the farther you get from that sprawling, overgrown beach town called "L.A."

**THE PLAS-TEX CORPORATION:**

Hats off to this energetic concern. They are pioneering a line of top quality housewares that is really something to see. Thermoplastics designed and molded in handsome style with the "heavy section feel" of melamine! In taking this courageous step, the Plas-Tex Corporation deserves the plaudits of the injection industry, for of course, the public is fed up with inferior, thin section housewares which cracks and breaks so readily. Even if only this one concern is engaged in producing a line of heavy section ware where advanced design and top quality are put ahead of price considerations, it will serve to keep alive public faith in all thermo-plastic products!

Plas-Tex is moving their large battery of modern presses into a huge molding room which is complete with large refrigeration circulator for controlling mold temperatures. This magnificent new press room should set some kind of record for neatness and efficiency, just as their new lines of molded goods are setting an unparalleled record of molded goods quality! It takes real courage to buck a trend, but The Plas-Tex Corporation is doing it with their new heavy section houseware line. The surprising thing is the public seems willing to pay for real quality and real weight in thermoplastic ware! Another thing—some of these heavy, new molded pieces are showing up a lack of plasticizing in various injection presses like high speed, thin section work never did, pointing up a need for better heating cylinders and an efficient, low cost preplasticizer that will run without breaking down!

**AN IMPCO RECORD:—**

Under Lyle Burford, West Coast sales of IMPCO machines have literally skyrocketed. Something like 60 IMPCOs have poured into West Coast shops while in the same period, the sales of **all other makes** of injection machines have dropped to an all time low—to where they almost can be counted on the fingers! I suppose this observation will evoke the usual snarls of disagreement, but you cannot deny what your eyes see just because your mind doesn't want to grasp a plain fact. Lyle Burford and IMPCO have done an outstanding job, and it goes to show what I have always maintained that business **is** personalities—that the individual **does** count for something—that a successful team **is** built up of indispensable men. You can recall the days when Jim Walcott (now Sales Manager of Reed-Prentice) had the corner on the West Coast injection machine market, and by his energy, personality and service, pushed Reed sales to the same pinnacle that Lyle Burford has now pushed IMPCO. Yes—the injection machine business is one of personalities. Outstanding field engineers like Walcott and Burford, deserve far more recognition than they get.

## Mold Design Topic At Toledo Section

John C. Purdue

Mr. John Andras of Detroit Major Mold and Die Company, East Detroit, Michigan, was the featured speaker at the May meeting of the Toledo section. Mr. Andras spoken on "Mold Design and Construction, particularly for large refrigerator parts."

Mr. Andras' talk was in a technical vein, illustrated by colored slides, and featured consideration of the machinery, standard duplicating and special equipment, and processes used by Detroit Major in producing such molds. Analysis required of steels to be used for the production of such molds was given, together with a discussion of the necessity for X-ray inspection of the blanks prior to machining.

Mr. Cordier, president of the Toledo section, announced during the business meeting that Bob Dunham and A. W. Kassay, both of the Toledo section, had authored articles on the plastics industry in Toledo published in **Toledo Technical Topics**, a monthly publication of the "Toledo Technical Council." Mr. Dunham's article is entitled "Toledo's Plastics Industry," and gives a brief discussion of the history of the plastics industry in Toledo, and of the present scope of the Toledo Plastics industry. Mr. Kassay's article is entitled "Plastics Development," and features a discussion of urea resins, melamine resins, reinforced polyester resins, and silicone resins.

## Industry Notes and News

Columbia Engineering Co. Inc., 113-119 Sussex Avenue, Newark 3, New Jersey, Manufacturers of Mold Bases and Mold Parts for the Plastic and Die Casting Industries, announce the appointment of George H. Beck as General Manager effective July 1, 1953.

Reed Plastics Corporation, compounders of thermoplastics material, Worcester, Massachusetts has added 10,000 feet of new manufacturing space to their operation. This, together with new production equipment makes possible a 40% increase in capacity.

Bruce Oakley has been named New England technical representative for molding powders by Hercules Powder Company. He replaces John G. Fuller, Jr., who is assuming new duties at the Hercules Experiment Station at Wilmington, Delaware.

# AROUND THE WORLD

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## AUSTRALIA

### AUSTRALIAN PLASTICS

Vol. 8, No. 93, March 1953

Abstracter: Albert Lightbody

**EXTRUSION OF PLASTICS by W.W.T.H. Ehlers**

This extract of a paper read before the Plastics Institute of Australia N.S.W. Section gives an excellent discussion of theory and practice of the various types of extruders in use.

**LACQUERING POLYSTYRENE MOULDINGS**

Reprint from British Plastics.

**NEW TYPE GERMAN HEAT SEALING EQUIPMENT**

Description of the operation of heat sealing equipment for sealing thermoplastic coated metal foils.

**GLASS REINFORCED PLASTICS IN THE AIRCRAFT INDUSTRY, G. C. Hulbert**

The materials, processes and designs of typical aircraft parts are discussed in some detail.

Vol. 8, No. 94, April 1953

**BASIC FEATURES INFLUENCING THE PERFORMANCE OF INJECTION MOLDING MACHINES, by E. Gaspar**

An excellent article covering the characteristics and performance of injection machines. Adapted from a lecture given by Mr. Gaspar in England, U.S.A., Canada, Scandinavia, and Australia.

**AUSTRALIA MAKES POLYESTER RESINS**

Announcement of the first commercial production of polyesters in Australia.

**AUSTRALIA MANUFACTURES LIQUID ENVELOPE**

The use of the sprayed peelable plastic film is covered.

**THREE REPRINTS FROM S.P.E. JOURNAL**

"Fully Automatic Molding" by Quentin M. White. "Extrusion Trends" by M. S. Greenhalgh. "The Biology of Plastics" by Louis C. Barail.

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## DENMARK

### PLASTIC

Vol. 3, No. 3, March 1953

Abstracter: Erik R. Nielsen

**SELECTION OF STEEL FOR PLASTICS MOLDS (CONTINUATION) by Peer Svendsen**

Discussion of steels suitable for molds produced by hobbing and of problems encountered in hobbing.

**NEW DYES FOR PLASTICS by R. Deverell-Smith**

A dye to be suitable for coloring of plastics must 1) be readily dispersed (otherwise the strength or shade may change during fabrication), 2) be heat-resistant (this property often is a function also of the plastics used; Polymon Violet BS breaks down at 150-160 C in a formaldehyde condensate, resp.), 3) be resistant to bleeding by contact or by solvent action (dyes which are insoluble in the plastic itself are generally less susceptible to bleeding), 4) be transparent (dyes insoluble in the plastic used give less transparency, but are preferred for the reason mentioned under 3), and 5) be light-fast.

**IMPROVED METHOD OF MAKING PALAEONTOLOGICAL REPLICAS by Eigil Nielsen**

Replicas of fossils are made with a plastisol based upon polyvinyl chloride (pevikon, type D.2) and dibutyl- or dioctyl-phthalate. The "cured" replica is brushed with graphite powder to be a black surface which will photograph well and which will permit the use of the replica as a mold.

Vol. 3, No. 4, April 1953

**PLASTICIZED VINYLS IN POWDER FORM, by S. J. Skinner**

The polymer, Geon 101 EP, stabilizer and filler are charged to a steam-jacketed mixer and preheated to about 212 F. Preheated plasticizer is added and mixed in for 15-17 minutes. The powder issues at about 212°F and may be cooled to prevent lump formation. Powder is suitable for extrusion, but not for calendering.

Vol. 3, No. 5, May 1953

**ARALDITE CASTING RESINS by Meyerhans**

General information on the casting of Araldite resins and the properties of the castings.

**"GLO-MOR" FOR DETECTION OF SURFACE CRACKS**

The surface to be examined is treated with "Glo-Mor" liquid (Manchester Oil Refinery, Twining Rd., Manchester, England) and exposed to ultraviolet light. The cracks show up with green fluorescence.

**PEARL ESSENCE, by G. Kohn**

Methods of application are given for pearl essence prepared from fish scales.

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## FRANCE

### MATIERES PLASTIQUES ET RESINES SYNTHETIQUES

May-June, 1953

Abstracter: Alfred P. Daignault

**BIOLOGY OF PLASTICS, Louis C. Barail**

Translation of article in SPE Journal, Vol. 9, No. 1, January 1953.

**IDEAS**

A pictorial presentation of certain plastic applications.

**BEFORE AND AFTER**

A translation with illustrations of an article in the "Bakelite Review" on modernizing of bathrooms with decorative laminates.

**VINYL FLOOR COVERING**

A translation of Robert K. Petry's presentation at the ninth SPE Conference which also appeared in SPE Journal, Vol. 9, #2, February 1953.

**PLEXIGLAS SIGNS, H. Schmidbauer; abstract from "Der Plastverarbeiter"**

General article on the use of Plexi-

glas in signs with a short section on methods and tools.

**PLASTIC AUTOMOBILE BODIES, (U.S. Information Service Release)**
A short outline of the history, advantages, and disadvantages of fiberglass automobile bodies.

**PLASTICS USAGE IN BRAILLE**
Description of use of plastic ink in printing braille as exhibited at Plastic Exposition at Newcastle upon Tyne.

**DOPE-DYEING OF ARTIFICIAL FIBERS (USIS Release)**

**INTRODUCTION OF ORLON-BASE MATERIALS IN AMERICAN CLOTHING MARKET (USIS Release)**

**INCREASE IN DEMAND FOR SYNTHETIC RUBBER (USIS Release)**

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## GERMANY

### KUNSTSTOFFE

April 1953

Abstracter: Anne Schwend

**PRODUCTION OF FILMS BY BLOW MOLDING, A. Romanowski**
In spite of the fact that the process of blowing films has been adopted only by very few plants in Europe, experience gained so far makes it possible that films thus produced are competitive to those produced in the U.S.A. Machinery needed and its set-up are described. Experience with the blowing of polyethylene, PVC, polyamides, polyurethanes, cellulose aceto-butyrate, polystyrene and monomeric trifluorochloroethylene is discussed. Surrounding conditions are emphasized: air drafts should be avoided under all circumstances to avoid unevenness in film thickness and deformation through one-sided air blows; absolutely undisturbed guiding of the tube must be guaranteed which necessitates elimination of vibrations. The aggregate described (and manufactured by Messrs. Paul Troester of Hannover-Wulfel), therefore, provides for blowing of the film from top vertically to the bottom to prevent that with a set-up working in opposite direction hot air from the blow head would rise upward and cold air would sink down. Unilateral influencing of the film tube through radiation such as direct sunshine should be avoided and room temperature, which should never sink below +53.6°F should be observed to cut out shrinkage folds on the hot tube.

**ELECTRICAL METAL DETECTORS FOR PLASTICS SCREENING, H. Schaffrath**
Stressing the need for elimination of metal scrap from plastic materials prior to processing in order to avoid failures in the finished product and prevent damage to molding machines and rolls, the author describes metal detectors which work on the principle of change in the magnetic alternating field due to conductivity or ferromagnetism of the metallic foreign matter to be sorted out. These detectors have the advantage that they can be used with all kinds of conveyer installations, do not require human surveillance, allow adjustment of sensitivity against small or big metal particles and register all magnetic and non-magnetic foreign matter as long as the material to be screened does not have magnetic properties itself or too high a conductivity. This detector can be connected to any kind of signal or stopping device and permits hooking up of magnetic traps or diverter bands for automatic elimination of the contaminated material. PVC and rubber compounds dyed with pigments containing ferric oxide as well as asbestos of relatively high ferric contents cannot be investigated by this method.

**MOLD OPENING AND EJECTION FORCES WITH MOLDED PRODUCTS HAVING CYLINDRICAL OR CONICAL SHAPE, H. Gastrow**
Prompted by the investigations about the influence of pressure, temperature and cycle on the molding process, published by Gilmore and Spencer in Modern Plastics, volume 27 (April 1950), tests were made to prove that with relatively thin section parts the decrease in pressure through back-flow of plastic material does not play a decisive roll in regard to the mold opening power, but rather the stress concentration created in the steel mold plates and the core by the high injection pressure. Though the result of the investigation and calculation of the mold opening force may not be generally applied since the tests were made with one tumbler mold only and were based on a given shrinkage rate, it may be stated that burnishing of the mold surfaces in the opening direction reduces the mold opening force required. Post-chromium-plating of the cavities often does more damage than good since it causes unevenness of the surfaces. However, grooves on the core deriving from cylindrical grinding should not be removed so that upon mold opening the core would not retract first. These tests already considered that a mold would open more easily if the pressure dwells for some time on the filled mold. Mold opening should only take place when the temperature of the section walls has cooled down to +104°F. in order to avoid sink marks, etc. Low conical shape of the outer mantle hardly influences the initial opening force, on the other hand conicity reduces the frictional work upon mold opening to a considerable degree, as f. to 1/100th with the mold under observation. The trend to scoring is decreasing accordingly.

**ELECTROTECHNIQUE AND PLASTICS—AN EXCERPT FROM FIVE PAPERS PRESENTED AT THE DUESSELDORF PLASTICS CONVENTION**
A survey on the application possibilities of various plastics in the cable and electric machinery industries, such as PVC, polyethylene, polyamides, ethoxylene resins, silicones, phenolic and cresol formaldehyde condensation products.

**PROPOSALS MADE BY THE TECHNICAL COMMITTEE PLASTICS OF ISO AT TORINO**
Results of the conclusions reached and proposals made by the individual working committees on the following subjects are published: a) nomenclature and equivalent special expressions; b) room temperature and conditioning procedure; c) general conditions for the testing of strength properties and flexural strength of rigid plastics; d) heat distortion tests based on ASTM D 618; e) determination of the extent of water absorption by test specimen.

**POLYTRIFLUOROCHLOROETHYLENE**
Excerpts from papers presented at the convention of the American Chemical Society at Atlantic City, N. J. in September 1952 by members of General Electric Research Laboratory, E. I. du Pont de Nemours & Co. and M. W. Kellogg Co.

**DETERMINATION OF RESIN AND FILLER KINDS OF MOLDED LAMINATES, Dr. E. Wandeberg**
Several methods were developed for the consumer to ascertain the kind of resin (phenolic or urea resins, shellac), the number of layers and the kind of paper or fabric filler contained in molded laminates. Holding the specimen into the flame of a Bunsen burner the kind of resin can be determined by the smell. Putting the specimen into a solvent will help to count the various layers; further washing of the specimen in the solvent until it is free from resin and dyeing it with iodine-potassium iodide solution or zinc chloride solution will produce various colors which permit determination of the kind of fabric used as filler.

**MOLDING OF HEAVY SECTIONS, G. Thayer**
Excerpt from the SPE Journal, April 1952.

**PROPERTIES AND USE OF POLYETHYLENE, H. R. Robertson**
Excerpt from SPE Journal, September 1952.

KUNSTSTOFFE, May 1953

**SYNTHETIC RESINS FROM COMPOSITIONS WITH ACTIVE METHYLENE GROUPS AND ALDEHYDES, Heinz Uelzmann**

A report about the first results obtained upon transformation of acrolein, croton-aldehyde and other aliphatic and aromatic aldehydes and suitable methylene components showing a multiple content of acetic acid or cyan-acetyl residue, under use of catalyzers. These tests proved that, generally, upon reaction of compositions of two or more active groups of methylene with aldehydes a molecule is formed which shows simultaneously an active group of methylene plus an active double bond and then enters into polyaddition with similar molecules. Products of oleic to resinous quality are obtained of which the latter may eventually be used as binders ar cast resins. Addition of fillers at a ratio of 1:1 made it possible to cast balls or bowls of high surface gloss which could be machined subsequently. It is proposed to call this new kind of resins "almekon resins."

**OBSERVATION AND TESTING OF THE MICROSCOPIC STRUCTURE OF CRYSTALLINE AND NON-TRANSPARENT PLASTICS, H. A. Stuart and U. Veiel**

A simple procedure in determining the crystalline structure and inhomogeneity and the residue content of undissolved spherulites consists in etching or polishing the cut or fracture surfaces of an injection molded piece and to investigate same under direct lighting. With the help of photographs the subject is elaborated on.

**A NEW RESILIENCE AND IMPACT STRENGTH TESTER AND RECORDER FOR FILMS, H. Klingelhoffer**

Since laboratory impact strength tests work with a slow increase of load which contradicts actual requirements in many instances, two simple devices were designed by Messrs. Karl Frank of Weinheim-Birkenau which allow to determine the elongation due to blow-like loading dependent on time, registering simultaneously a diagram of time and way of load. This drop hammer instrument uses an exchangeable sheet of wax paper for pendulum registration. Speed of writing surface passing the recording pen may be adjusted. For upholstery materials the resilience tester is simply put onto the material in question; packaging films are clamped into the circular diaphragm of the impact strength tester. In addition to the change of shape values upon breaking packing materials indicated by the "Puncture Tester" (General Electric Comp.) the two testers described permit determination of depth of impact, lasting impression, elasticity constant upon impact and resilience, fatigue strength at successive impact loads.

**TIN RICINOLEATE—A NEW STABILIZER FOR PVC, Ferd. Furter**

Based on observations in U.S.A. that ricinoleic acid esters show good heat and light stability plus the experience with the well-known stabilizing properties of tin salts have led to a combination of the two materials which yielded a product of excellent light, temperature and heat stability. Non-toxicity of tin ricinoleate, its viscosity reducing effect, the transparency obtainable in films and its excellent lubricating properties persuade to conclude that this new product constitutes a stabilizer for manifold purposes. Tentative test results are released, more extensive tests are under way to broaden the sphere of applicability.

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## GREAT BRITAIN

### BRITISH PLASTICS, MAY 1953

**Abstracter: Gerald Eisner**

**NEW MANUFACTURING TECHNIQUES FOR POLYTHENE BOTTLES**

This article describes the manufacture of a 3-piece squeeze bottle. Excellent pictures show the operation of sealing the base to the body and then testing for 15 psi air pressure on a rotating jig.

**THE ANNEALING OF POLYSTYRENE, by F. J. Parmenter**

Four types of internal stresses are carefully described and molding and annealing conditions which effect these stresses are considered. These stresses include mechanical ones due to differential cooling in the molding, mechanical stresses caused by overheating of secondary operations, orientation stresses due to the molding operation and orientation stresses caused by polymer molecules being forced out of their equalibrium position during molding.

**BONDING PLASTICIZED P.V.C. TO METAL, by A. Blake**

Mr. Blake describes the advantages of using a film of semi-rigid P.V.C. between steel and P.V.C. paste to ensure proper bonding.

**MOULDED BOATS AT THE BIF**

Some excellent pictures of (7) different polyester and phenolic boats are shown in this article.

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## SPAIN

### REVISTA de PLASTICOS

### Vol. 4, No. 20, March-April 1953

**Abstracter: John B. Ballard**

**STANDARDS FOR PLASTICS, by Mario Mas Sanroma**

Comments on provisional Spanish standards for mechanical and chemical tests and tests of molding qualities of plastics.

**MELAMINE PLASTICS, by J. L. Orbiso**

Explanation of the qualities of melamine.

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## UNITED STATES

### ELECTRICAL MANUFACTURING

### May 1953

**Abstracter: Gerald Eisner**

**TEMPERATURE-HUMIDITY EVALUATION OF PLASTICS, by Albert Brent**

The author, Standards Engineer for Sperry Gyroscope Co., first discusses the importance of testing electrical properties of plastics under dynamic instead of static conditions. Characteristics such as insulation resistance and dielectric strength of commercially available laminated and molded thermosetting plastics undergo degradation of a greater degree when the materials are submitted to temperature-humidity cycling than when exposed to non-cyclic conditions.

Next, Mr. Brent describes in detail the method of preparing test samples as well as the cycling and testing procedures which his company has adopted. In addition we are given a table of averaged results of temperature-humidity cycling on selected laminated and molded thermosetting plastics. Characteristics reported on are Dielectric Strength, Dielectric Constant, Power Factor, Linear Dimensions and Weight.

One interesting discovery made during the testing was the almost complete recovery in insulation resistance of a number of the plastic samples four days after the cycling was stopped.

SPE PRIZE PAPER CONTEST

See Announcement on Page 3

# SECTION NEWS

*Edited by*

Stanley Bindman

*Jamison Plastic Corp.*
*71 E. Sunrise Highway*
*Freeport, New York*

## Importance of Colorful Life is Stressed By Doner at Ontario Section Meeting

R. H. Strong

Color is a very potent tool in manufacturing, merchandising or just getting along in life.

This is the belief of H. Creston Doner, director of design and color for Libbey-Owens-Ford Glass Company, who is showing fellow designers the 29 popular House and Garden colors matched in six-inch disks of urea-formaldehyde plastic made by Plaskon Division of LOF Glass.

In 1953 the buying habits of 90,000,000 Americans will be influenced by these House & Garden color predictions. They are used by 269 leading manufacturers of paints, furniture, radios, television sets, appliances, textiles, and floor coverings. More than 7,500 retail stores throughout the country will have tags on 4,000 items of merchandise of using these colors—a billion-dollar stock.

What are the popular colors for the year ahead? Such descriptive colors as citron, mustard, Bitter green, green olive, willow, leaf, forest, sky blue, cerulean blue, Dresden blue, Middy blue, Siamese pink, carnation, flame, cherry, sand, pebble, driftwood, hot chocolate, nasturtium, terra cotta, dove gray and gunmetal.

"Color is so much a part of our daily lives that we are apt to overlook the potent force it plays in this world of ours," says Mr. Doner.

"When we stream into traffic of a morning we are controlled by the red and green lights. We stop and go by color whether we are in an automobile, train, plane or bus.

"Color may register a state of mind; in industry, it may alert workmen to hazards; in international affairs, it may have political significance; in a flag, it may inspire patriotism. To the scientist color identifies the elements, while to the artist a color may be the material which captures a shaft of sunlight.

"Important to business and industry, however, is the fact that color stimulates sales. The right color may often mean the difference between having a product collect dust on the stockroom shelves or move as a fast turnover item," said Mr. Doner.

The new large color swatch disks primarily illustrate how plastics may fit into the "world of color." Plaskon Division of LOF Glass has developed more than 11,000 colors in the last 20 years to satisfy the ever-growing demand for color, but it is important to find those colors which harmonize with current merchandise in the many fields where consumer demand is registered.

Some of the current popular colors started as predictions five or six years ago and now have reached a point where they are used extensively by decorators and designers.

While providing a perfect color range for matching and selecting the right color for a given product, the new Plaskon color disks also illustrate the fact that there is available urea or melamine plastic molding materials for a wide variety of beautiful things, ranging from buttons to electric fixtures or automobile parts.

Mr. Doner, who developed for his company a color system for factory painting that relieves eye-strain, creates pleasant working conditions, and provides adequate warning colors, thus solving an important wartime personnel problem during World War II, has lately become interested in the design and merchandising possibilities in colorful plastics.

His survey finds that the House & Garden colors are now used by 62 paint manufacturers, 46 furniture makers, five radio and television manufacturers, 40 appliance firms, 82 textile mills, and 34 floor-covering makers. In addition, they now have the full advantage of plastics in color-Plaskon urea and melamine molding materials.

## Labor Problems Aired At Chicago Meeting

M. A. Self

The Chicago chapter of the SPE had one of it's most interesting meetings on May 13, when Mr. Albert Smith, of the firm Fyffe and Clarke, spoke before the group. Mr. Smith gave a brief history of the labor movement and then discussed in detail the impact of NLRB decisions on the law. He made specific recommendations and what management can do to handle some of its difficult labor problems. Mr. Smith was kept speaking by his audience for nearly two hours and he was asked from the floor to speak again to our group. Those of us who missed the May meeting to join the SPI on the Queen of Bermuda Conference Cruise look forward to having Mr. Smith with us again at another meeting.

The May meeting was our first to be held in the spacious quarters of the Western Society of Engineers at 84 East Randolph St., in the "loop." Any visitors to Chicago are cordially invited to attend our meetings, and we are sure they will find the new meeting place conveniently located and with excellent facilities. Beginning with the September 16 meeting, our meetings will be held on the third Wednesday of each month.

The Chicago group has lost one of its good members and an excellent Membership Committee Chairman, inasmuch as Henry Carlson of Koppers Company has been promoted to Koppers' Pittsburgh office as their Chemical Products Manager. Mr. L. W. (Curly) Anderson, Plant Superintendent of Chicago Molded Products Corporation has been appointed to fill his place as Membership Committee Chairman.

The Golf Outing held June 18, 19 and 20 at beautiful Nippersink Manor resort was well attended and much enjoyed. Everyone received a prize, however, Messrs, Lohr, Van Nordwick, Brosius and Gaines were the four who shot in the low 70's.

## New York Hears "Plastics from Retailers Viewpoint" And Report of British Productivity Team

Arthur M. Merrill

The New York Section concluded the season with a regular dinner meeting on June 17 at the Gotham Hotel, with some 80 members and guests attending. Guest speakers were Frank Gottheimer, technical writer, who gave a "Report of the British Plastic Productivity Team," and Ephraim Freedman, director of Macy's Bureau of Standards, who discussed "Plastics from the Retailer's Point of View."

Mr. Gottheimer summarized the report by the British team which visited and surveyed the American plastics industry in 1952, and compared the industry with that in Britain. The team reported that the American thermoplastics molders use more plasticizers and preheating than do the British, and also tend to modify their machines to use larger and fewer heating bands. American thermoplastics molds are stronger and better designed than their English counterparts. Although American thermosetting molding machines are generally older than those used in Britain, they are more productive because of faster cycles achieved by improved materials and more widespread use of pelleting and preheating. In general, the old machines used in America for thermosetting molding are being modernized by adaptations and modifications rather than being replaced by new machines. The team also reported that molded items in Britain show a much greater emphasis on fine finishing, apparently because of a more critical attitude on the part of consumers.

Mr. Freedman reported on a recent survey of Macy's buyers to determine their attitude toward plastics. Some of the points brought out in this survey were as follows: opaque styrene buttons and ornaments for dresses are not satisfactory because they are not readily identifiable by cleaners; plastic bristles in toothbrushes are often held in place inadequately; plastic-encased wire clothesline cord is proving very acceptable; polyethylene garment bags and storage bags are quite satisfactory while vinyl bags, although popular, are often softened by paradichlorbenzene moth preventives; vinyl yard goods are often inferior products, and show a great need for informative labels; properly made four-mil vinyl raincoats are acceptable for utility use, but thinner or sewn-seam coats are not satisfactory; unsupported vinyls are not suitable for use in luggage because of appearance and excessive flexibility; acetate bottoms for golf club bags have been cracking in service; in toys other than dolls, there is a definite trend away from styrene and certain other rigid plastics because of undue cracking; plastic wading pools have been acceptable in service; glass fiber reinforced plastic bulk toys are satisfactory if proper attention is given to impact resistance; vinyl inflatables have demonstrated the value of informative labeling; there is a trend from styrene to polyethylene refrigerator dishes and containers; melamine tableware is popular, but needs some improvement in brilliance of finish; urea dishes are acceptable for picnicware; and styrene wall tile has good acceptance but is somewhat expensive.

The conclusions brought out by Mr. Freedman and the spirited discussion which followed his talk were: (1) certain plastic products are misapplications because of insufficient durability; (2) more attention is needed towards improved finishing, design, and color of certain items; (3) there is a definite need for good informative labels on plastic items; (4) more education is needed of the consumer and retailer regarding plastics; and (5) further development and use of quality standards is necessary.

Section president Saul Blitz, Tico Plastics, presided over the meeting, and program chairman Irvin I. Rubin, Robinson Plastics Co., introduced the speakers. The SPE national officers and directors, who met in New York during the week, were guests of honor at the meeting. National president Walter F. Oelman, Standard Molding Corp., spoke briefly and thanked the New York and Newark Sections for their efforts in behalf of the Society. A surprise feature was the presentation of a gift to Mrs. Bess R. Day, executive secretary, from the New York Section in token of her services to the Society. The presentation was made by our national director, Stanley Bindman, Jamison Plastic Corp., who is also SPE national vice president.

Table favors were distributed through the courtesy of Empire Brushes, Inc., Naugatuck Chemical Division of United States Rubber Co., and Robinson Plastics, and the meeting closed with a drawing for six door prizes contributed by Jamison Plastics.

The following six new members were added by the Section during June: Jerome D. Bassin, Republic Aviation Corp.; Walter Brenner, Brusher Plastic Molding Corp.; Thomas E. Dudley, Eastman Chemical Products, Inc.; Melvin L. Maisel, Fiberoid Doll Products Corp.; Paul J. Metzger, Hercules Powder Co.; and Ely Tanenbaum, Harrison Co., Inc.

The New York Section is sponsoring a motion picture film contest among its members. This contest is aimed at fostering interest in the plastics industry; providing the members with an opportunity for self-expression; contributing to the general advancement of plastics engineering; and building up a library of films on plastics that can also be available to the plastics vocational high school course in New York. Entries may deal with any phase of the plastics industry, and must be in silent 8- or 16-mm. film, either black and white or in color, must not exceed 10 minutes in projection time, and must not be professionally produced. All entries must be in by December 15, 1953. The three judges for the contest are: George Kleber, Board of Education, City of New York; Stanley Bindman, Jamison Plastic Corp. and SPE national vice president; and Islyn Thomas, Thomas Mfg. Corp. and past national president. Three prizes will be given, as follows: First, $50.00 savings bond; Second, $25.00 savings bond; and Third, one year's free membership in SPE.

## Epoxy Resins Described At Saint Louis

Philip B. Beltz

The June meeting of the St. Louis Section was held at the Melbourne Hotel on the 23rd, with approximately 55 persons in attendance, despite the 100° weather.

The speaker for the evening was Mr. J. E. Carey, Supervisor, Rigid Plastics Technical Service, of the Shell Chemical Company.

Mr. Carey's talk on epoxide resins was extremely well received by the members and guests, as was apparent by the question and answer session at the close of the talk, and further by the lengthy informal discussions after the close of the meeting.

His discussion very thoroughly covered uses of the epoxides for adhesives, laminating, casting, and potting, as well as the mold making qualities of a filled "Epon" resin.

His talk was illustrated by distribution of samples of glass and synthetic fabric laminates, wrapped pipe, adhesive samples, cast and potted samples, foams, and molded articles.

The meeting was closed with the usual attendance prize drawings. The prize this month was donated by Al Werner.

The section will hold no summer meetings. The next meeting will be held as a joint meeting with the American Chemical Society on October the 8th.

## WINNERS OF THOMAS E. ORR AWARD

James R. Purdon, Jr.

James M. Flynn

The annual Thomas E. Orr award, given by the Cleveland-Akron section in memory of T. E. Orr, was won this year by J. R. Purdon, Jr., and John M. Flynn. The award consists of a junior membership in SPE.

James Ralph Purdon Jr. on graduation from grade school received the Legion award for citizenship and scholastic achievement.

While in Central High School in Akron, he was president of the senior class and senior Hi-Y, and a member of the National Honor Society. He received the manhood cup award and was Salutatorian of his class.

Jim likes all sports but especially enjoys playing basketball and football. His chief recreation is fishing.

At Akron University, where he is majoring in chemistry, he belongs to Alpha Chi Sigma and Scabbard and Blade Societies.

Mr. John M. Flynn was born December 9, 1929 in Cleveland, Ohio. His college preparatory education was obtained at Butternut Ridge School and North Olmsted High School in North Olmsted, Ohio. He received a Bachelor of Science degree in Chemical Engineering at Case Institute of Technology in June, 1951, and will receive a Master of Science degree at Case in June, 1953.

Interest in the field of plastics began while he was an undergraduate and has been itensified during graduate work. Course work in polymer chemistry has included courses in plastics technology, protective coatings, and the physical chemistry of polymerization.

Mr. Flynn has gained practical experience in plastics technology through research and thesis studies during this period spent in graduate school. His thesis study was entitled "Polymerization of Styrene in the Presence of Carbon Black." He has also spent six months in basic research on vinyl plastigels and plastisols, and was recently awarded the Heil Process Equipment Corporation Fellowship for the study of the resistance of commercial plastics to corrosive reagents under service conditions.

## Ontario Members Are Active in Work For Government and Education

R. H. Strong

The Ontario Section of the SPE has representatives on the Canadian Government Specifications Board and its activities on plastics. It is represented on the Committee for Plastic Tableware by Bill Lacroix, Joe Schneider and B. Kellam, and on the Committee on Plastic Pipe by T. A. McLellan and B. Kellam. Designs and Specifications for tableware for the Armed Services and government departments have been drawn up. Many items are in use with an excellent record. Recently the National Industrial Design Committee gave this Panel an award for excellence of design of one of the items.

Activities on Plastic Pipe have resulted in the major portion of specifications for Civil Defense and Central Mortgage and Housing. This has been temporarily set aside to develop specifications for polyethylene pipe to permit the inclusion of this material in the Provincial Plumbing code recently issued. It is expected that later work will include specifications covering the use of plastic pipe for electrical conduit and other applications.

Mr. B. Kellam, our Professional Activities Chairman, has given several talks on plastics as part of his activities. The graduating class in Chemical Engineering at the University of Toronto, and the combined chemical and electrical groups of the Ryerson Institute of Technology were given a talk on engineering aspects of plastics. A talk was given at the annual meeting of the Canadian Association of Consumers, a National woman's organization, the subject being "Plastics in the Home."

## Rezolin Plastics Are Described at L. A. Meeting

Austin H. Herbst

Mr. Howard Stevens, Sales Manager; Mr. George Adams, Staff Engineer and Mr. Norry Hastings, Chief Chemist for the Rezolin Company of Los Angeles spoke before a joint meeting of SPI and SPE on the subject "Rezolin Toolplastic Materials, Their Uses and Applications."

The casting of liquid plastic resins for the manufacture of tools, jigs and fixtures to be used in the fabrication of metal and non-metallic parts was described.

Three types of casting resins are currently being used by Rezolin, namely: an acid catalyzed liquid phenol formaldehyde resin; a similar resin, but containing a foaming agent that expands the resin to 5½ times the original volume during the curing operation; a thermoplastic hot melt type of resin based on ethyl cellulose.

The foamed phenolic is available in two densities and is used as a core material in the fabrication of plastic tooling to reduce weight and lower resin cost.

The thermoplastic ethyl cellulose hot melt resin produces cast tooling with the high impact strength required for drop hammer work. The compounds are available in pelletized form. The tools prepared from the hot melt composition can be reprocessed after the useful life of the tool has been realized.

In the past cast plastic tooling has been used to a greater extent by the sheet metal forming industries. However, there has been a great deal of interest recently in the use of cast phenolic molds for the wet lay up of fiberglas reinforced polyester parts.

It was stated that cast plastic molds will be used by one of the major manufacturers of a 100% fiberglas-plastic automobile sports body in the near future.

## Detroit Mourns Cheyney, Bedell

LaVerne E. Cheyney, age 42, Contract Research Department Manager, Minnesota Mining & Manufacturing Company, died suddenly May 21.

He was born in Akron, Ohio, where he was educated in secondary schools and the University of Akron. He received a M.S. from the University of Pennsylvania and a Ph.D. from Ohio State University (1938). He was analytical chemist at B. F. Goodrich (1933); research chemist at National Aniline Division, Allied Chemical and Dye Corporation (1939); research chemist, section leader at Goodyear Tire and Rubber Company (1939-45); assistant professor at University of Akron (1941-42); supervisor Battelle Memorial Institute 1945-48; Research Director Pollock Paper Corporation 1948-49; Development Supervisor Minnesota Mining and Manufacturing 1949-.

L. E. Cheyney

He was constantly active in the local section of the American Chemical Society, serving as chairman of many committees; and he was active is ASTM. He belonged to AICE, AIC, SPE, AAAS, TAPPI, Detroit Rubber and Plastic Group.

Honorary societies: Sigma Xi, Phi Lambda Upsilon, Delta Epsilon Chi. He was the author of forty technical articles specializing in rubber and plastics, and he was granted sixteen U. S. patents and many foreign ones.

LaVerne Cheyney was devoted to church and family.

It is with deep regret that the plastics industry records the passing away of Mr. R. Curtis Bedell one of its molding pioneers. Curt passed away on Friday, June 26th.

R. Curtis Bedell

Curt was born in Onsted, Michigan in 1909. He received his college degree from the University of Michigan in 1933. Following his graduation he entered into the plastic field in his association with Reynolds Spring and later Continental Can.

Curt has been associated with Michigan Molded Plastics, Inc. of Dexter, Michigan for the last ten years. He was this organization's Vice President in charge of engineering and also a member of their board of directors.

Curt has been a member of long standing of the SPE. He has served on the Detroit-Section Board of Directors and was consulted on numerous occasions in matters concerning organizational policy.

Curt is survived by his wife and two children who reside at 5870 Portage Lake Road, Dexter, Michigan.

### PLASTIC WELDING TRAINING COURSE

American Agile Corporation, pioneers in the welding of thermoplastic materials identified as Polyethylene and Unplasticized Polyvinyl Chloride, announces the opening and operation of their Welding Training School.

These Welding Courses embrace lectures, design, theory, welding exercises, advance course and design of welding construction reinforcements, structural design as influenced by temperature and chemical resistance.

These Plastic Welding Training Courses and facilities of the school are open to all those who wish to enter into the structural fabrication of thermoplastic materials as well as those who wish and desire this knowledge for their self-sustaining purposes against the ravages of corrosion in their particular industry or plant.

Complete details and information, together with a booklet identifying the various lectures, exercises, and advance course in welding and flame spraying is available by writing to the American Agile Corporation, P. O. Box 168, Bedford, Ohio. New classes will be forming within the next six weeks.

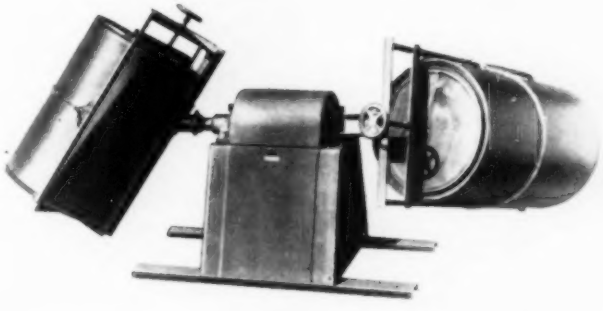
## Prof. Church is Promoted

**JAMES M. CHURCH,** recently promoted to full professor of Chemical Engineering at Columbia University, New York, will be on sabbatical leave this coming year with the du Pont Company. He is joining the Polychemicals Department in their development laboratories at the Experimental Station in Wilmington, Delaware.


**IMS DRUM TUMBLER**

*Made Exclusively for*

**Dry Coloring Injection Materials For The Injection Process**



**Compact . . . Extra Power for Bigger Batches . . . Higher Speeds for Faster Mixes . . . Takes Any Size Drum . . . The Leader in Dry Coloring Work**

**Price, crated, with ¾ HP 220-440 v. 60-cycle, 3-phase motor and adjustable barrel holders — $452.50**

F. O. B. Cleveland — Immediate Shipment

*Send for special bulletin giving helpful hints on dry coloring for the injection process.*

**INJECTION MOLDERS SUPPLY CO.**

**3514 LEE ROAD WYoming 1-1424 CLEVELAND 20, OHIO**

## Toronto, SPE Conference

(Continued from page 7)

than in many sections of the U. S., careful investigation is advisable before choosing a location for Winter sports.

Mr. G. W. Beatty is General Chairman of the Tenth Annual National Technical Conference.

G. W. Beatty

He holds a B.Sc. degree in chemical engineering from the University of Toronto. Before attending university he served three years as a lieutenant in the Canadian Army. He joined Dow Chemical of Canada Limited as a sales engineer and is now manager of the plastics sales division.

Malcolm Wilkinson of Canadian Industries Limited is co-chairman of the Tenth Annual Technical Conference of the Society of Plastics Engineers, Inc. He was born in Yorkshire, England and received his early education there. He later attended McMaster University in Canada.

With the outbreak of war, Mal Wilkinson enlisted in the Royal Canadian Navy and became a lieutenant engaged in anti-submarine work.

Prior to joining C-I-L, he was in the engineering departments of Rogers Majestic Corporation, Canada Wire and Cable Company, and radio station CFRB, in Toronto. He was also with the Lightening Fastener Company at St. Catharines, Ontario.

He joined C-I-L in October, 1946, as sales representative of the plastics division, in Montreal and was appointed technical sales representative in Toronto in 1947, and Toronto district sales manager of the Polythene Division in 1952. Mr. Wilkinson is immediate past president of the Ontario Section of the Society of Plastics Engineers and a member of the Society of the Plastics Industry.

Malcolm Wilkinson

Thomas J. Carey

Co-chairman for the Tenth Annual Technical Conference of the Society of Plastics Engineers, Inc., is Thomas J. Carey of Canadian General Electric. He is also chairman of the Publicity Committee. Tom Carey joined the company's plastics operations in 1940 and signed up for a special four year course in plastic mold making and mold design. Following graduation, he was transferred to administrative control work at Canadian General Electric Company, head office, Toronto.

In 1945, he transferred to district sales work in Toronto District and in 1948, was appointed Manager of the plastic section, head office, in charge of administrative control on plastics.

In 1952, he was appointed manager of sales and service, with offices at the CGE plant, Coburg, Ontario.

Active in the Society of Plastics Engineers and the Society of Plastics Industry, he has held offices in both groups.

## Designing for Plastics

(Continued from page 25)

this form of beading is that any slight sideways misalignment between the cavity portions in the respective mold blocks would not be plainly visible on the finished molding and, moreover, the feel of the knob would not be impaired by off-setting the cavity portions.

The design D (Fig. 1) shows what is, perhaps, the best style and shape of beading to be employed with such a knob component to achieve the maximum appearance and decorative values.

In this case the bead is made with a rounded crest, which may be semi-circular as illustrated, or slightly less than that shape, as desired. The sides of the beading are blended to the general curved surface of the knob by small fillets as before.

The mold construction and cavity lay-out to produce this style of beaded knob will be exactly as with the previous examples, the only difference being that of machining the cavity enlargements to the quarter-circular shape indicated. The beading is disposed on the part to bring the parting line a—a and any flash likely to occur there exactly on the centre line.

In this present diagram the beading is shown in rather a more pronounced form than would be necessary with an actual molding, in order to illustrate clearly the specific shape adopted.

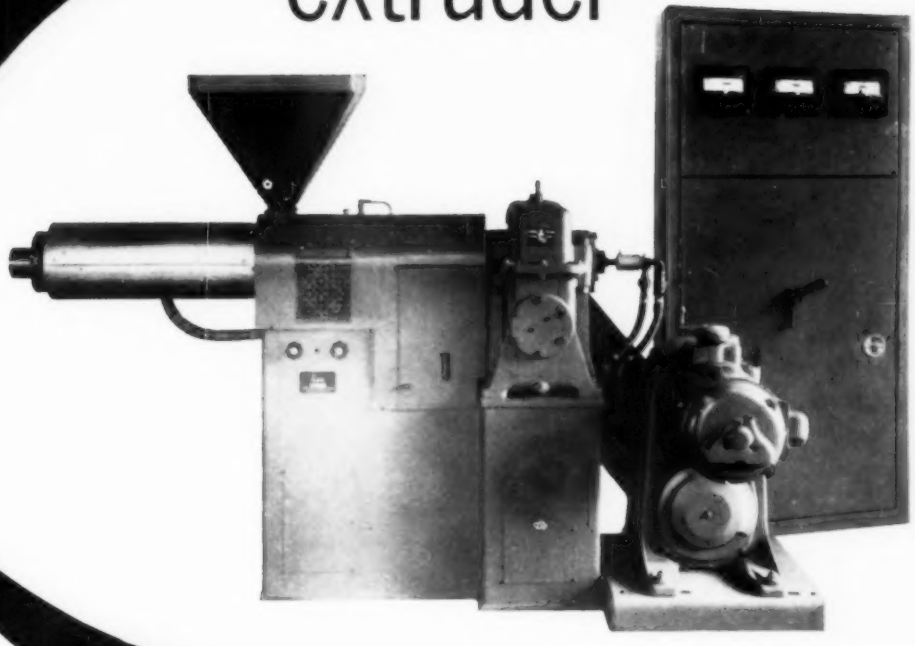
The task of removing flash from such a beading would be equally simple, and would offer greater freedom to remove completely any unsightly scars or markings without in any way destroying the general shape and appearance of the knob. A rounded beading of this kind will be the easiest to handle by a user. It will also be appreciated that with all these examples the beading is employed solely to improve the appearance, and in no wise will add to the strength of the component.

### JENKINS JOINS THOMAS MFG. CORP.

As the latest of many recent and important additions to its sales division, Thomas Manufacturing Corp., Newark, N. J., announces the appointment of Thomas D. Jenkins to assist Sales Manager Bert W. Maldment. Mr. Jenkins, former manager in the retail field, brings to the company a wealth of merchandising experience gained during 26 years of active and successful administration of stores handling a wide variety of toys and other merchandise.

Egan

# extruder



Remote Control Panel

**FOUR SEPARATE MAIN COMPONENTS**

● "Tailored" Screw ● Independent Thrust Bearing Housing

● Individual Feed Section ● Heavy Wall Cylinder

Internal wiring for extruder and control panel complete to coded terminals for quick installation at any location.

**ALL WITH IMPROVED FEATURES**

for increased production, reduced maintenance and complete flexibility. Designed to meef *ANY* requirements. Can be supplied complete with dies and take-off equipment.

Write for details or invite our representative to call

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Designers and Builders of Machinery
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FIGURE IV—Some correct and incorrect designs for unplasticized PVC parts.

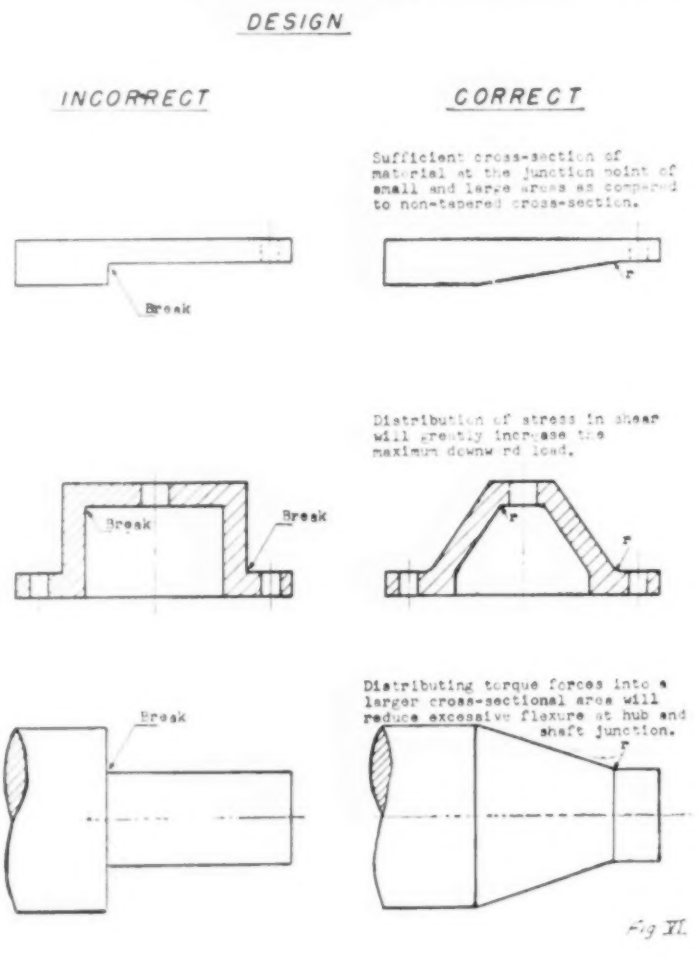


Fig XI.

## Unplasticized PVC

(Continued from page 20)

values below 160°F if an unplasticized polyvinyl chloride has been excessively adulterated. Tensile values (ASTM 638-49T) falling below 8000 psi. also indicate undesirable modifications.

Physically, unplasticized polyvinyl chloride should meet a group of tests which will establish just how well the converter has processed the basic material. The divisions of material types are based on the processing equipment used and on the physical incongruities peculiar to the extruder, calender, laminating press, and transfer mold. These divisions may be established as follows:

**Extruded Rods & Bars—**

1) Brittleness
   A hammer blow on material held firmly in a vise should not result in glass-like shattering.
2) Non-homogeneity
   Acetone immersion for several days should result in swelling only, with no evidences of cracks, bubbles, separations, or porosity.

**Extruded Pipes & Tubes—**

1) Brittleness
   A hammer blow should not result in glass-like shattering. It should be possible to flare the end of the wall of the tube or pipe with pliers or wrench with no evidence of brittleness.
2) Non-homogeneity
   Acetone immersion for several days should result in swelling only, with no evidence of cracks, bubbles, separations, or porosity.

**Laminated Sheets—**

1) Brittleness—Bending
   A strip 1/8 to 1/4" thick, of laminated sheet at room temperature should submit to repeated bending without cracking.
   Impact
   There should be no evidence of excessive brittleness on striking the sheet with a hammer.
2) Homogeneity
   **Hammer Blow & Knife Test**—Continuous delamination should not be possible with a hammer and chisel.
   **Steam—Oven and Hot—Gun Test**—A sheet should not delaminate or blister when subjected to 320°F for 15 min. in steam oven or when subjected to blast from hot-air gun at approximately 500°F.
   **Acetone Test**—A sheet should not show evidence of delamination after 1-2 hours immersion in acetone at room temperature.

**Molded Blocks—**

1) Brittleness—Impact or Hammer Blow Test—Same as for rods.
2) Non-homogeneity—Acetone Test —same as for rods.

Once the chemical and physical characteristics of a specific unplasticized polyvinyl chloride stock has been determined as being satisfactory, the burden of obtaining expected service from a particular application lies with the fabricator. His problems may be classified as those of design and assembly.

In the shaping of parts the fabricator must avoid sudden contour transitions and notches. Heavier cross sections than would be normal with other structural materials must be used in regions of high stress. Design is done with a view toward distributing predictable stresses over wider areas. The concentration of stresses at a point must be avoided. Some

desi[illegible]s are illustrated in Figures 3 and [illegible].

With regard to assembly, it might be said that since the material lends itself so well to shaping by the normal wood and metal tools, fine workmanship should be expected. Tolerances can be held quite close, and there should be no evidences of cracks, gouges or tool marks on finished fabrications.

Hot gas welding is used to such a great extent by the fabricator that its influence in affecting the merit of an installation cannot be overemphasized. The raw stock which the fabricator uses must first of all be capable of a good weld. Some high molecular weight resins cannot be welded unless the resin and the welding spline have been modified although such changes are to the detriment of other equally important properties. The use of such PVC resins is to be avoided.

Once the basic weldability of a material has been determined, the fabricator must be constantly aware of the following rules in all subsequent work:

1) The design of the weld should conform to the recommended illustrations (Figs. 3 and 4) and the conceptions of stress distribution previously mentioned.

2) The surfaces to be welded should be clean and smooth but not polished.

3) The amount of heat applied by the welding gun should be uniform along the length of the weld, and it must be sufficient to effect melting of the rod surface and softening of the rod and melting of the weld-bed surfaces without localized decomposition.

4) A uniform pressure must be maintained on the welding rod at right angles to the plane of the weld to insure intimate contact between the melted surfaces of the rod and the bed.

5) The utmost uniformity should be sought in a weld. Waviness along the weld, and elongation of the rod must be avoided.

6) The fewest rods possible should be laid in a single bed because each weld increases the danger of strains and overheating with subsequent weakening of the complete weld.

7) If an error is made in the course of a weld, work should be stopped and the faulty area scraped out and replaced by a properly laid bead.

Throughout this article there may seemingly have been an overemphasis on the problematical features of unplasticized polyvinyl chloride. In the United States, it is a relatively new structural material, and only in knowing its limitations as well as its advantages can it be fully exploited without having misapplications hinder its acceptance in its field. There has been no long-term testing of domestic unplasticized polyvinyl chloride because it has been made here for only a few years. In Europe, however, fabrications of unplasticized PVC have given satisfactory service for many years. The utilization of unplasticized PVC through the whole of the European Chemical Industry has expanded rapidly since 1946. For example, at the Badische Anilin & Soda Fabrik (B.A.S.F.) at Ludwigshafen, Germany, unplasticized PVC is specified in all places where structural properties permit. Farbenfabriken Bayer have over one-half million pounds of unplasticized PVC in corrosion resistant installations at its Leverkusen, Germany, plant.

Today the United States has surpassed all other countries in the production of plastics, not because it lacks the classical materials which were used before, but because of the conviction that new and better materials have been created.

Just how rapid the utilization of unplasticized PVC will be in the United States is dependent upon its early recognition and acceptance by our construction and chemical engineers as an excellent corrosion resistant material.

3 ways to improve plastics production! save money!
1 Hopper Loader
Motor-driven conveyor feed for injection and extrusion machines. Automatic flow at any pace you set. Clock timer stops and starts feed as desired. Easily installed, timesaving, safe.
2 Hopper Dryer
For continuous drying and pre-heating of material. Easily installed on all standard makes of injection and extrusion machines. Saves handling—saves space—speeds production—economical to operate.
3 "Die-Temp" Control
Positive control of mold temperatures at constant level between 100-400 degrees F. Fast-acting electric immersion heaters in tank. Economical, simple to operate; mounts on wall or on machine. Stand optional.
THORESON-McCOSH, Inc.
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## BIBLIOGRAPHY

1. **Krannich W.,** "Kunststoffe im Technischen Korrosions — Schutz" Carl Hanser Verlag 1949
2. **Wehrenalp, E. B.** and **Saechtling, H.,** "Jahrhundert der Kunststoffe" ECON Verlag 1952
3. **"S.P.I. Handbook"** Society of Plastics Industry, Inc. 1947
4. **Seymour, R. B.** and **Frey, J. H.,** "Plastic Processing Equipment Today" **Chemical Engineering** 59(3) 1952 McGraw-Hill
5. **Dammer, O.,** "Kunststoffe an Stelle von Metallen?" Schweissen und Schneiden Jahrg. 3 (1951) Sonderheft.
6. **Huscher, J. L.,** "Unplasticized Polyvinyl Chloride" **Chemical Engineering** 59 (11) 1952 McGraw-Hill



## CREDITS

Badische Anilin and Soda Fabrik—Ludwigshafen a Rhein, Germany
H. N. Hartwell & Son, Inc.—Boston, Massachusetts.
W. Krannich, Figures 1, 3, 4.
Industrial Plastics Fabricators—Norwood, Massachusetts.
B. F. Goodrich Chemical Company—Cleveland, Ohio (Table V).
Firestone Plastics Company—Pottstown, Pa.; Chemical Sales Division.

## Temperature Control Unit

Sterling, Inc., 3738 N. Holton Street, Milwaukee, announces the addition of Model 6003 to the Sterlco line of Temperature Control Units.

The Model 6003 Temperature Control is extremely compact (occupies less than 3 square feet floor space), and designed for permanent installation or for use where it is important to save space. The dual assembly arrangement offers two independent heating, cooling and circulation systems. Large immersion heaters of 9000 watts each are controlled by sensitive thermostats in tanks of small total water capacity for fast action.

Primary use is in the plastics industry to control mold temperatures, but compactness and efficiency of operation make it adaptable to many other industries where accurate temperature control of dies, molds, printing rollers, etc., are a prime equipment.


Help Wanted

PLASTIC MOLD DESIGNER

Apply by Letter or in Person

MICHIGAN MOLDED PLASTICS, INC.

DEXTER, MICHIGAN


## Printed Circuits

(Continued from page 12)

opposite side of the piece from the etched pattern, with their tinned leads inserted through the holes. Usually the conductors are fluxed prior to this operation with a non-corrosive rosin-type flux. All the necessary connections are then made between the components and the conductors by a single short dip in a molten solder bath. After dipping, excess lengths of the protruding leads are trimmed off.

### Economy in Production

Printed circuits are practical principally because of their simplicity and uniformity. They are particularly adaptable to very complex commutators and switching networks where sub-miniaturization is required.

The great savings are in assembly labor, inspection time, and overhead. Assembly labor is obviously reduced by the automatic or semi-automatic systems. Inspection time is cut because of the excellent reproducibility of printed circuitry and its comparative simplicity. Overhead is lowered because many more units may be produced in a given amount of factory space.

### Applications

The future of printed circuitry in general is enormous. Developments to date have barely scratched the surface of possibilities. Their uniformity, ruggedness and opportunity for use as sub-assembly plug-in replacement offers additional advantages in the maintenance of equipment in which they are used. Applications of the prefabricated circuits encompass a very large field in low power apparatus including radio, television, hearing aids, automatic signals and other electronic devices.

# Classified Ads

### SITUATIONS OPEN

SALES REPRESENTATIVE WANTED—LIQUID TYPE PHENOLIC AND UREA RESINS. (Solid Phenolics also available but temporarily have full schedule). Will make commission or other suitable arrangement. Box No. 2353, SPE Journal, 513 Security Bank Building, Athens, Ohio.

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Large custom molder requires the services of a man capable of managing Reinforced Plastics Division. Must be qualified to supervise Engineering, Estimating, Production and Development work. Thorough knowledge of polyester resins, molding techniques, essential. Salary commensurate with background and experience. Send resume to American Insulator Corporation, New Freedom, Pa.

### FOR SALE

For sale two Used 8 ounce IMPCO Injection Molding Machines in good operating condition. Can be seen operating. Stanley Berg & Company, Frick Building, Pittsburgh, Pa. Phone Grant 15490.

**WANTED**

Graduate chemist or chemical engineer—Age 25-35

**EXPERIENCED**

In the compounding and extrusion of various plastics in the wire and cable industry

**EXCELLENT OPPORTUNITY**

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